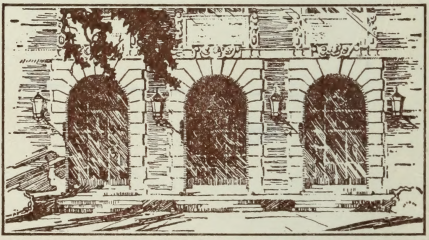

Texts
Guy

PRINCIPLES

OF

FORENSIC MEDICINE.

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FIFTH EDITION,

REVISED AND ILLUSTRATED BY 188 WOOD ENGRAVINGS.

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PRINCIPLES

OF

FORENSIC MEDICINE.

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PREFACE

TO

THE FIFTH EDITION.

THE original aim of this work was to furnish, for teacher and learner alike, a Text-book, in which principles and results should be clearly and briefly stated, disencumbered of minute details, and containing only such illustrative cases as could, for the most part, be compressed into a narrow compass.

But this brevity and condensation were found quite consistent with an original treatment of several subjects, and with a laborious analysis of facts which others had left undigested, and therefore useless or misleading. Of such elaborate analysis, the first edition contained several examples, in the chapters on Personal Identity Infanticide, Legitimacy, and Unsoundness of Mind.

Some of these analyses, having served their purpose of demonstrating the uselessness of certain tests and standards of comparison, were omitted from the second edition; many illustrative cases were also either curtailed or set aside, thus leaving room for a considerable number of wood engravings, comprising drawings of seeds, minute structures, and chemical reactions as seen under the microscope.

The second edition thus became the first English treatise on Forensic Medicine in which such illustrations were largely used. It also contained some new chemical facts and tests, arising out of the method then recently suggested, of obtaining sublimates of

arsenic and mercury, on a flat surface of glass, so as to admit of ready examination by the microscope.

In the third edition, the principle of illustration was carried much farther than in any similar work. Many additions had been rendered necessary by the interesting discovery of Helwig, of Mayence, that the method of sublimation on flat surfaces admitted of extension to the alkaloids. The results obtained by this means (so easy of application in all cases, productive of such characteristic appearances in many), were then for the first time described and illustrated; and new diagnostic methods, as well as distinctive tests for some important poisons (especially strychnia, morphia, and cantharidine) were pointed out. The third edition, therefore, had many attributes of an original work, especially in the Toxicological part, and notably in the chapters on Methods of Procedure, and on the Diagnosis of the Poisonous Alkaloids and Analogous Active Principles. Of the wood-cuts illustrating microscopic objects, several were taken from photographs by Dr. Julius Pollock.

In preparing the fourth edition, the original Author had the advantage of the co-operation of his successor in the chair of Forensic Medicine; so that the work is, in part, the production of one now engaged in teaching; and was throughout subject to a double revision, resulting in a considerable condensation of old matter, and an addition of more than 50 pages of new. Some subjects were rewritten, others (chiefly Toxicological) added, and some leading illustrative cases, as that of the Welsh Fasting Girl, and the Tichborne case, given at some length; the Tichborne case being reserved for an Appendix.

In this, the fifth edition, some subjects, such as Feigned Diseases, have been greatly curtailed; others somewhat enlarged; the Tichborne case, in its most direct bearings on the subject of identity, has been transferred to the text; and some tables and a few illustrations omitted. The subject of the detection and identification of minute quantities of poison by the method of sublimation and by tests applied under the microscope, as well as by

means of crystalline forms, has been transferred to an Appendix, and other important alterations and additions have been made in the Toxicological section of the work.

Where it was necessary to do so, the work of the original author has been distinguished by the letter G.

September, 1880.

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PRINCIPLES

OF

FORENSIC MEDICINE.

INTRODUCTION.

The State avails itself of the knowledge, experience, and skill of the medical man for three distinct purposes:—1. For the care of soldiers and sailors, prisoners, paupers, lunatics, and others for whose safety it makes itself responsible; 2. As analysts and officers of health; and 3. As skilled witnesses in courts of law.

The duties of the medical man in the first of these capacities are such as devolve upon him in the ordinary practice of his profession; but he is expected to prevent as well as to cure disease, and to add to professional skill administrative talent.

As health officers, however, and as witnesses in courts of law, medical men have duties to perform for which the ordinary practice of their profession affords no adequate preparation, medical education, till of late years, no proper training, and medical literature no sufficient guidance.

The distinctness, importance, and difficulty of these duties led at length to the establishment of a distinct science, taught in separate courses of lectures, treated in separate works, and engaging the attention of men more or less separated and set apart for the practice of the corresponding art.

This new science either embraced all the duties the medical man may be required to perform on behalf of the State, in which case it received the name of Political or State-Medicine; or it was divided into two sciences, the one known as Hygiène or Public Health, the other as Forensic Medicine, Juridical Medicine, Legal Medicine, or Medical Jurisprudence.

As the term Forensic Medicine expresses with sufficient clearness the application of medical knowledge to legal purposes, it is used in the title of this work. The term *medico-legal* is also

in common use, as in the phrases "medico-legal knowledge," "medico-legal experience," "medico-legal skill."

The history of Forensic Medicine is that of most other sciences. Necessity or convenience gives birth to an art practised by persons more or less skilful, without guidance from general principles; but its importance, and the responsibility attached to the practice of it, soon create a demand for instruction, oral and written, which gradually assumes a systematic form. Thus it was that the Science of Medicine sprang from an empirical art of healing. In like manner, the Science of Forensic Medicine took its rise in the necessity of bringing medical knowledge to bear on legal inquiries relating to injuries or loss of life; the medical witness being at first without guidance in the performance of his duty, and so continuing till a growing sense of the important bearing of his work on the interests of society, and on his own reputation, created a demand for instruction that could not fail of being supplied. Cases were accordingly collected, arranged, and commented on, illustrative facts sought after, special experiments devised and performed, till at length the medical witness received in books and lectures the same distinct instruction as the physician or surgeon at the bedside had already derived from written or oral teaching in the theory and practice of medicine, or of surgery.

But the importance of medical testimony received an earlier recognition from Continental Governments than from the public or the medical profession; for the first State recognition (1507) anticipated by nearly a century the first medico-legal treatise (1597); and the first appointment of medical men to perform medico-legal duties followed soon after, in France in 1603.*

The history of Forensic Medicine in England is of more recent date. It begins with the publication, in 1788, of Dr. Samuel Farr's 'Elements of Medical Jurisprudence,' and was first taught in lectures at Edinburgh, in 1801, by Dr. Duncan, sen., the first professorship being conferred by Government on his son in 1803. The new science soon justified the distinction thus conferred upon

* The following dates have an historic interest. The penal code of the Bishop of Bamberg, proclaimed 1507. A uniform penal code adopted by the Diet of Ratisbon, 1532. *Constitutio Criminalis Carolina*, published 1553. Letters patent, presented to his first physician by Henry IV. of France, empowering him to appoint two surgeons in every city and large town to examine and report on wounded or murdered persons, 1603. Publication at Frankfort of the Methodus Testificandi of Condronchus, 1597, and of the works of Fortunatus Fidelis and Paul Zacchias in 1598 and 1621. First course of lectures on Forensic Medicine by Michaelis at Leipzig about 1650. See Traill's 'Outlines of Medical Jurisprudence.'

it, and made good its claims to more general recognition. It is now taught in all our medical schools, and recognised by the examining bodies; its principles are being constantly applied in our courts of law; and England continues to contribute her fair share of observation and research towards its extension and improvement.

The application of the principles of the science—in other words, the practice of it as an art—devolves, for the most part, on the medical practitioner. But those specially versed in the entire subject, or in important parts of it (such as Toxicology), or eminent in certain branches of practice (such as midwifery and the treatment of the insane), are occasionally summoned to give evidence.

There are many reasons why the medical man should approach this class of duties with apprehension. He is conscious of the importance that attaches to his evidence; he is wanting in the confidence which a more frequent appearance as a witness would impart; he is painfully alive to the unstable foundation on which many medical opinions rest; he knows that it is not easy in practice to observe the rules of evidence with which in theory he may have made himself acquainted; and, above all, he shrinks from the publicity attendant on legal proceedings, the unreasonable licence allowed to counsel, and the disparaging comments of the Bench itself.

Sympathising in these reasonable apprehensions, some writers of eminence and most authors on Forensic Medicine have tried to prepare the medical witness for his duties by setting forth the precautions he should observe both prior to and during his attendance in court; and by special directions for conducting medico-legal inquiries under the heads of "Post-mortem inspection," "General evidence of poisoning," "Unsoundness of mind," &c.; the general precautions to be observed in the witness-box being made the subject of distinct treatment under the title MEDICAL EVIDENCE.

Before treating of the dtuies of the medical witness, it may be well to show the number of cases that occur year by year in England and Wales of a class to give rise to medico-legal inquiries. The following figures are extracted from The Annual Report of the Registrar-General for the year 1877 ;—

Deaths by accident or negligence, suicide, murder, and manslaughter, 22,684.

Sudden deaths (causes unascertained), 2543.

Premature births, malformations, atrophy and debility, 18,179. Total, 43,406.

The following special causes of death were recorded in the census year 1871:—

Causes of Death.	Accident or Neglect.	Suicide.	Total.	Males.	Females.
Poison	261	131	392	233	159
Fractures and bruises .	6,837	—	6,837	5,777	1,060
Gunshot	102	63	165	157	8
Cuts and stabs	111	301	412	339	73
Burns and scalds . . .	2,612	—	2,612	1,355	1,257
Drowning	2,605	317	2,922	2,348	574
Hanging	—	548	548	448	100
Suffocation	1,504	—	1,504	876	628
Lightning.	28	—	28	23	5
Total	14,060	1,360	15,420	11,556	3,864
Otherwise	929	135	1,064	782	282
Grand Total	14,989	1,495	16,484	12,338	4,146

In the same year, 1871, the deaths by accident or negligence were distributed between the sexes as follows:—Poison, men 159, women 102; Gunshot, men 94, women 8; Cuts and stabs, men 93, women 18; Drowning, men 2175, women 430; otherwise, men 683, women 246.

The suicides were distributed as follows:—Poison, men 174, women 57; Gunshot, men 63, women 8; Cuts and stabs, men 246, women 55; Drowning, men 173, women 144; Hanging, men 448, women 100; otherwise, men 99, women 36.

In the year 1877, the premature, sudden, and violent deaths gave rise to 26,287 inquests, of which 18,168 were held on males, and 8119 on females: and as the qualified practitioners in England and Wales fall far short of this number, it follows that, if medical evidence were called for at every inquest, and the duty of attending at inquests were distributed equally, each member of the profession would attend at least one inquest every year.

The committals for trial arising out of these 26,287 inquests amounted to 375, of which 109 were for murder, and 166 for manslaughter. In 1636 instances the death was returned as suicidal.

The number of cases requiring medical evidence in our higher courts of law may be judged of approximately from the printed returns of commitments for trial for offences against the person. In the year 1876-77 these amounted to 2374, and comprised—

Murder and attempts to murder	102
Various attempts to maim and injure	170
Assaults	1150
Manslaughter	244
Concealment of birth	81
Rape and assaults with intent	490
Unnatural offences	137
	2374*

If we add to the occasions for medical evidence arising out of these crimes, the civil cases in which skilled medical evidence is required, and proceedings in respect of lunatics, the occasions on which medical men are summoned to courts of law, either in the service of the State, or on behalf of individuals, will appear very considerable—certainly numerous enough, and important enough in themselves, to justify all the attempts which have been made to construct a science of Forensic Medicine, to teach it systematically in books and lectures, and to draw up a code of instructions for the guidance of the medical witness in the performance of his duties.

MEDICAL EVIDENCE.

The medical man may be summoned as a witness to *state* facts, and to *interpret* them. In the one case he is a *common* witness, in the other a *skilled* witness or *expert*. When he gives his opinion on the facts observed, and the views expressed by others, it is as a skilled witness, and he is equally a skilled witness when he expresses his opinion on the facts he has himself observed.

In performing these duties there are certain precautions which the witness ought to observe, and certain legal requirements of which he should not be ignorant.

1. He should "use his best endeavours that his mind be clear and collected, unawed by fear, and uninfluenced by favour or enmity." (Percival.) He will not find it easy to maintain this impartial frame of mind when the crime alleged is one of unusual enormity; when popular feeling runs high for or against the accused; or, in times of public agitation, when his evidence tends to discredit some popular movement, or deep-rooted prejudice. Nor, when he is engaged as a skilled witness, or *expert*, for the prosecution or for the defence, must he deem himself free from

* These figures are taken from the annual report, entitled 'Judicial Statistics,' 1877.

the risk of partiality, even though, after hearing all the facts which should influence his opinion, he feels that he can conscientiously give his evidence in support of the side for which he is retained.

2. The medical witness requires to be specially cautioned against expressing an opinion on the general merits of the case under inquiry, thus offending against an admitted principle of English law, that "when scientific men are called as witnesses, they are not entitled to give their opinion as to the *merits of the case*, but only as to the *facts proved on the trial.*

3. A special caution is also required against indulging a feeling of misplaced humanity, or an equally misplaced condemnation of the law on the score of undue severity. Both these feelings too often found expression in former treatises on the lung-tests, and in early trials for infanticide. But the witness should understand that he is not responsible for the consequences to which his opinions may lead, provided always that they are the result of cautious inquiry and due reflection. Percival accordingly treats "The dread of innocent blood being brought upon us by explicit and honest testimony," as "one of those superstitions which the nurse has taught, and which a liberal education ought to purge from the mind."

The witness approaching his duties with a mind thus free from bias, requires some instruction as to the mode in which his evidence should be given.

1. Bearing in mind the distinction just laid down between a common and a skilled witness, he should be cautious not to obtrude his opinions when facts only are required of him, nor dogmatically to assert as facts things which are merely matters of opinion. He should answer the questions put to him, whether by counsel, court, or jury, clearly and concisely, and if these do not elicit the whole truth, supply what is wanting.

2. His statements should be made, and his opinions expressed, in the plainest and simplest language; and he should avoid as much as possible all technical terms, and all figurative and metaphorical expressions.

3. The medical witness ought also to abstain from quoting authorities in support of his opinions; for though the rule of exclusion has not always been rigidly acted on, the common usage of our courts of law is certainly to disallow these appeals. Nor is this exclusion open to any serious objection, for the witness is supposed to make himself master of the views of the most eminent writers on the subject-matter of his evidence, and to use them as aids and guides to his own special inquiries.

But though the witness may not cite authorities, he may be

asked whether A or B is an esteemed authority with his profession, and whether he (the witness) coincides with some opinion expressed in his works. If the witness answers in the affirmative, he becomes the exponent of the opinion to which he thus gives his assent.

The foregoing observations relate chiefly to the mode in which the witness should give his evidence. The precautions to be observed in order that his evidence may be admissible still remain to be considered, under the following heads :—

1. *Notes.*—When observing any facts which, at a future time, may become the subject-matter for legal inquiry, the medical man should not trust to his memory, but commit them to writing, either on the spot, or as soon as possible after the transaction to which they relate. If (as in performing a post-mortem examination) it is necessary to resort to dictation, the notes of the amanuensis should be immediately examined and corrected.

The witness may use these notes in court to *refresh* his memory, but not to supply its place. If they were not made till some time after the events to which they refer, or if, having been made at the proper time, they have been entirely forgotten, they will not be admissible.

2. *Confessions.*—A culprit may make a confession of guilt to his medical attendant. This, to be admissible in a court of law, must be free and voluntary, uninfluenced by threat, promise, or bribe. No sort of inducement should be held out to make it, no leading questions should be put, and no comments made; but the medical man should reduce the statement to writing as soon as possible, read it over to the person confessing, obtain his signature to it, and countersign it himself.

At the same time the greatest care should be taken to ascertain the bodily health and mental state of the party making the confession. The necessity of this caution has been amply proved by cases in which, during febrile attacks, or after prolonged exposure and hardship, as well as in cases of delusional insanity, confessions have been made of murders and other heinous crimes which had never been committed. In times now happily passed away, innocent persons, under like conditions of body and mind, made confession of impossible crimes, such as witchcraft.

3. *Death-bed or Dying Declarations.*—These are admitted as evidence in cases of homicide, where the death of the deceased is the subject of the charge, and the circumstances of the fatal injury the subject of the declaration. It is assumed that the declarant, having lost all hope of recovery, is induced to speak the truth by considerations as powerful as an oath administered

in a court of justice. It is not necessary, however, that he should *express* his conviction. It may be inferred from the nature of the injury, or from other circumstances of the case. But if any hope whatever be entertained, or may be inferred to exist, whether it be spontaneous or on the suggestion of others, death-bed declarations cannot be received in evidence.*

But the person, or persons, inculpated by the declarant's statement are not precluded from giving evidence as to his state of mind and behaviour in his last moments. They may be allowed to show that the deceased was influenced by vindictive motives, or was not of a character to be "impressed by a religious sense of his approaching dissolution."

As dying declarations are but confessions of the most solemn kind, the same rules of procedure apply to them as to confessions. The medical man should put no leading questions, but only such as are necessary to clear up ambiguity. He should commit the declaration to writing, read it to the dying man, and obtain his assent, and, if possible, his signature to it. But if this cannot be done, he should make a memorandum of the declaration at once, while it and the words used are fresh in his memory. To this document the witness will be allowed to refer to refresh his memory when he comes to give evidence. Another essential part of his duty is to ascertain the exact state of the declarant's mind, whether he is calm and collected, or otherwise, and whether he is under the influence of any strong bias, or undue feeling of resentment.

4. *Hearsay.*—This is not admissible as evidence unless it form part of the *res gestæ*. A medical witness, therefore, though he may state in evidence the words he has heard used in direct reference to the case which forms the subject of inquiry, could not cite a case in support of his opinions, if it consisted in part, as it must needs do, of statements made by the patient, his friends, or attendants.

5. *Secrets.*—The medical man, in the course of his professional attendance, may receive secret information which, under ordinary

* In a recent case (Trial of Bedingfield for the murder of Mrs. Rudd, Nov. 1879), Lord Chief Justice Cockburn, by treating as a dying declaration what other high legal authorities would have considered as a part of the *res gestæ*, and therefore admissible, shut out an important piece of evidence. "A woman's scream was heard from the house, and immediately afterwards the deceased was seen coming out with her throat cut, making a statement which, according to the rules of evidence, was not admissible, and in about ten minutes she was dead. Mr. Pitt-Taylor, in a letter to the *Times* (Nov. 15, 1879), quotes no less than five legal authorities in favour of his opinion that the statement of the woman Bedingfield ought to have been admitted as part of the *res gestæ*.

circumstances, he would be bound not to divulge. But it should be understood that in a court of justice he may be compelled to divulge these secrets.

It is now no longer necessary to warn the medical man against taking part in duels, even though his object in being present is to save life, and not to destroy it. But if in this, or in any other way, he has acted illegally, he, in common with other witnesses, is not obliged to criminate himself.

6. *Wills.*—A medical man may be required, on an emergency, to draft the will of a patient, or to witness the instrument. In taking the instructions of the testator, he should limit himself to such inquiries as may enable him to understand his wishes. He should write them in the fewest, simplest, and clearest words on one side of a sheet of paper, append the place and exact date of the transaction, and at the foot of the document (leaving room for two signatures) the following words :—" Signed by the above-named testator, in the presence of us present at the same time, who have hereunto signed our names as witnesses thereto, in the presence of the said testator, and in presence of each other." The testator and witnesses must attach their signatures in accordance with these words.

The medical man should take care to observe the condition, bodily and mental, of the testator; and he would do well to make a note of all the circumstances of the case while they are fresh in his memory. Wills so made have been disputed, and the medical man has been summoned as a witness, and submitted to a searching examination.

PART I.

CHAPTER I.

PERSONAL IDENTITY. AGE. SEX.

When called upon to examine the body or remains of some unknown person, we may have first to ascertain the sex and the age, and then to identify the individual by characteristic marks; or these points may have to be considered separately, both in living and in dead persons. The three subjects are here grouped together, and placed in the most convenient order; sex last, from its connection with the subjects of Chapter II.

PERSONAL IDENTITY.

Questions of identity are often raised in courts of law; as when a claim is set up to an inheritance, or a man who has been robbed or assaulted has to identify the thief or the person who has injured him. A witness may also be required to identify an acquaintance; and a jury may be empannelled for the sole purpose of trying the question of the identity of an escaped prisoner. So also as to persons found dead; and in coroners' inquests the first step taken is to identify the body, or such parts of it as are forthcoming.

The subject of personal identity, then, divides itself into—

1, *The Identity of the Living*; 2, *The Identity of the Dead.*

I. IDENTITY OF THE LIVING.

The medical man may be required to examine, with a view to identification, alleged deformities or injuries, scars, or discolourations of the skin or hair; and to express an opinion on the changes that may be wrought in stature, face, and person, by time, exposure, and hardship. It is also within his province to give evidence on the influence of the like causes on the mind and memory.

In order to give completeness to this subject, some questions will be briefly noticed in which medical evidence is not needed.

In cases of disputed inheritance, much stress is laid on family resemblance. The celebrated Douglas Peerage case was decided in favour of the claimant, Archibald Douglas, in consequence of his proved resemblance to Colonel Stewart, his father, the twin brother, Sholto, who died young, having equally resembled Mrs. Stewart, the mother. In this case, Lord Mansfield strongly insisted on this resemblance of child to parent, as well as on the strongly contrasted fact that in an army one hundred thousand strong, every man may be known from another; if not by feature, size, attitude, and action, by voice, gestures, smile, and expression.

Though these statements generally hold good (and not of men only, but of herds of cattle and flocks of sheep), still there are not wanting instances of persons having no connection by relationship or descent who have yet borne the closest resemblance to each other. Of this mistaken identity, Lord Chief Justice Cockburn, in the Tichborne case, cited, among other illustrations, a case on the Western Circuit, in which two men were tried and convicted for murder. The identity of one of them was sworn to by numerous witnesses; but it was afterwards proved that, at the very time of the murder, he was undergoing punishment for picking a pocket hundreds of miles away. A most curious case of this kind occurred in 1772, when one Mall, a barber's apprentice, was tried at the Old Bailey for robbing a Mrs. Ryan. The witnesses swore to his identity, and the whole court thought him guilty; but, on referring to the books of the court, it appeared that on the day and hour of the robbery he was on his trial at the bar where he then stood for another robbery, in which he was likewise mistaken for the thief.

When the question of identity turns on the changes which time, coupled perhaps with fatigues, hardships, and privations, may work in the personal appearance, it becomes one of unusual difficulty. Cassali, a noble Bolognese, left his country at an early age, and was supposed to have died in battle; but, after thirty years, returned, and claimed his property which his heirs had appropriated. His appearance was so changed that he was imprisoned as an impostor. Zacchias was consulted, and in his report, expressed his opinion that such a change might have been wrought by age, change of climate, diet, mode of life, and disease, and as Cassali had left home in the bloom of youth, had been exposed to the hardships of a military life, and, if he might be

believed, had languished for years in prison, the judges, influenced by this opinion, and by the fact that the heirs could not prove the death of Cassali, decreed the restoration of his estates.

The general question thus submitted to Zacchias assumes a more definite form when, as in the French cases of Baronet and Martin Guerre, a false claimant is confronted with a real one, or alleges his identity with a person long since dead, as in the Tichborne case;* or when, as in this case, the claimant is alleged not only not to be the man he is personating, but some other person.

In all such cases of disputed identity, great importance attaches to the existence, or absence, of such marks as nævi, moles, deformities, scars of foregone disease or injury, and tattoo markings. The Tichborne case has also given renewed importance to the effect of lapse of time in changing the stature, form, and features, and in destroying or modifying the memory and habits of thought, as expressed in words spoken or written: and it has shown the importance that may attach to photographs, as the most exact representation possible of the personal appearance at the time when they were taken.

Of Scars and Tattoo Markings.—1. *Scars.*—When a claimant presents himself without the marks or scars known to have characterized the individual whom he personates, his case must break down under personal examination; but if these marks or scars are found upon him, they are the strongest possible evidence in his favour, and would, indeed, be conclusive but that they may have been fraudulently imitated, or may be most improbable, but still possible, coincidences. That such coincidences may happen, is proved by the case, quoted by Beck, of Joseph Parker, tried at New York, in 1804, for bigamy. He was mistaken for Thomas Hoag, whom he not merely resembled, but had in common with him a scar on the forehead, a small mark on the neck, and a lisp in his speech; but, unlike Hoag, no scar on the foot. That he was Parker, and not Hoag, was proved to the satisfaction of the jury by an alibi.

Removal of scars.—The question of identity has sometimes turned on the possibility of removing scars, upon which some difference of opinion has been expressed. Thus, in a Belgian

* The reader will find the cases of Cassali, Baronet, and Martin Guerre, with other leading cases from the 'Causes Célèbre,' quoted and criticised by Foderé, in the second chapter of his 'Traité de Médicine Légale;' and he is referred for a lucid account of the extraordinary case of Martin Guerre to the *Times*, December 12, 1871. It is the case in which Arnauld de Tilh, who had possessed himself of the secrets of Martin, contrived to be recognised by his family, and even accepted, seemingly in good faith, by Martin's wife. (See a brief abstract of this case appended to this chapter.)

case that occurred in 1847, M. Vandelaer stated that scars might be removed by time or by artificial means, and the physicians of the prisons of Valvorde and Ghent confirmed this opinion by stating that prisoners are in the habit of effacing scars by applying a salted herring to them. MM. Lebeau and Limanges, on the other hand, contended that scars could not be removed. On this subject, Casper states that the length of time during which a scar subsists depends on the depth to which the tissues of the skin have been injured. Scars of superficial injuries which have only affected the epidermis, or scarf skin, and left the true skin intact, may entirely disappear. But we may confidently assert that even the slight wounds caused by bleeding or cupping, if they have penetrated the whole depth of the cutaneous tissues, and *à fortiori*, such wounds, injuries, or ulcers as have caused loss of substance, followed by granulation, leave behind them permanent scars.

Scars may, however, fade with the lapse of time; and, on the other hand, be rendered more distinct by friction, pressure, blows, or irritants. Thus, Devergie states that the white brand-mark of the galley-slave which has apparently disappeared may be rendered visible by slapping the spot with the hand till it reddens.

The belief that scars may wholly disappear is probably founded on the very slight marks left by extensive wounds when they heal by what is technically called the "first intention." Thus, in the case of a maniac who had completely removed the parts of generation, the place of the wound was marked by a faint white line which a casual observer might overlook; and the severe floggings of former times, which left the back quite raw, are traceable after some years only by very fine white lines on the back and sides, and, where the knots had fallen, by little circular pits. In a case in which we were consulted, the entire absence of both kinds of mark enabled us to state with confidence that the man could not have been, as was alleged, very severely flogged (G).*

The removal of scars has another important bearing on the question of identification. It may happen that an impostor, aware that evidence will be forthcoming that he has certain tattoo or other superficial marks on his person which the man he

* Of the permanency of such scars as those left by bleeding, a good illustration is afforded by a case in which two physicians, one 66, the other 64 years of age, having distinct recollection that they were bled in the arm at about 7 years, and not since, the marks of the operation were, in both cases, perfectly distinct (G).

is personating had not, resorts to heat or strong corrosives, or such agents as the vaccine virus, to erase the marks in question. The substituted marks thus become a very strong presumption of imposition, especially if the person bearing these marks cannot or will not explain the way in which they were produced, or offers some explanation that refutes itself. It will be presently shown that the claimant in the Tichborne case has two such marks on his left arm.

Shape, situation, and depth of scars.—These may render great assistance in determining a question of identity. The operations of bleeding, cupping, and vaccination, like the punishment of the lash, leave highly characteristic appearances. So also do burns and scalds, blisters, caustic, tartar emetic ointment, issues, and setons. Diseases, again, such as small-pox, scrofulous and crural ulcers, lupus, and carbuncle, leave indelible marks behind them.

Changes in colour of scars.—All scars, without exception, pass through two distinct stages—that of inflammatory redness (the immediate consequence of the injury sustained), and that of brown discolouration. In phlegmonous erysipelas, and after the application of blisters, mustard poultices, and other strong irritants, the skin, which was red during the inflammatory stage, assumes a dark brown or coppery hue. This it retains for months, and even for three or four years. At length, and by degrees, the skin resumes its healthy colour. But sometimes, when the inflammation runs high, the brown discolouration is followed by a third stage, or that of bleaching. Thus we have seen, after the lapse of two years and a half, the spot to which a large blister had been applied defined by a white margin, and white decolouration occupying the whole surface on a level with the surrounding healthy skin (G.). Such *surface scars* follow the less severe forms of herpes, boils that heal after slight destruction of texture, and even incised wounds and lancet cuts, where the edges have not been brought together, and some slight superficial ulceration has taken place. In those cases in which the inflammation, however produced, is followed by ulceration, and consequent destruction of tissue, and still more where gangrene sets in, the scars are wholly or in part sunk beneath the surface. In these cases, too, the scar passes through the three stages of inflammatory redness, brown discolouration, and bleaching. The cause of a scar may often be inferred from its appearance, and the situation in which it is found. Thus a linear scar, or a round or oval surface scar, on the arm, ankle, or temple, follows bleeding; parallel linear

scars on the loins, shoulders, nape of neck, or other fleshy part would be the resnlt of cupping; a crucial linear scar on any part of the body would indicate a boil treated by incision; two parallel linear scars on the nape of the neck, shoulder, or inner side of the upper arm, would mark a seton; and a depressed, puckered scar on the same parts, an issue: a honey-combed disc near the insertion of the deltoid muscle indicates the operation of vaccination; a white disc with dotted border may follow a boil that has healed without operation; and every form of cicatrix in the neck, on the chest, and elsewhere, may follow scrofulous abscesses. Scrofula, small-pox, syphilis, and lupus, in common with injuries by gunshot, burns, and escharotics, may leave behind them scars of every size and form.

Healing of scars.—This is influenced by many causes, such as age, constitution, and state of health, the situation of the scar on flat, rounded, or hollow surfaces, on parts subject or not subject to motion, and in the direction of muscles or across them.

Distinctness of scars.—This will depend on the complexion, and the tint of parts adjacent. Thus scars are less apparent in persons of fair complexion, when the skin approaches in tint to the whiteness of the scar itself, and more distinct over a blue vein or discoloured portion of skin. Hence scars are rendered more visible when the skin is reddened by blows or friction.

Age of scars.—As has been stated, all scars, whether arising from injury or disease, are first red, then brown, then white and glistening. The redness, as a rule, lasts two, three, or four weeks, during the period of healing; the brown discolouration for several months, or even for a few years; the bleached appearance for the rest of life. But the duration of each stage is subject to great variation; as is seen in some cases of small-pox, where the scars are white and shining at the end of six months; while in others they remain brown even after two or three years. Scrofulous ulcers, too, sometimes leave coloured scars for the whole of life. A scar, then, that retains its inflammatory redness cannot be of long standing; one that has a brown or coppery colour may have existed for months or years; a white, glistening scar, quite free from colour, must have been of long standing; but we cannot even guess at its age.

Some scars are particoloured, perhaps brown in the central parts, with a white puckered halo; or white in the centre, with a brown margin. Thus a scar of ten years' standing from a boil consisted of a white disc, with a circular margin of brown spots. Sometimes we have an opportunity of comparing a recent scar with one of longer standing due to the same

cause, as in a prisoner who had two attacks of herpes, one under the right, the other under the left clavicle. The first, of a few months' standing, displayed the rash in all its details in dark brown; the second, of many years' standing, consisted of a group of scattered white cicatrices (G.).

2. *Tattoo markings.*—The presence or absence of these marks may, as in the Tichborne case, prove of the first importance; and the question naturally arises whether these marks can disappear or be removed. Most tattoo marks are certainly indelible if not interfered with. But that they may in some cases disappear is proved by the observations of Casper, Hutin, and Tardieu; though these authorities differ widely as to the proportion of cases, Casper alleging the high fraction of 1 in 9, Tardieu the much lower one of 1 in 25. Much depends on the kind of colouring matter employed. Cinnabar, blue ink, and common ink create less permanent marks than Indian ink, soot, washing blue, coal dust, or gunpowder. Skilfully performed tattooing with gunpowder may be pronounced indelible. The difference in the durability of the marks depends on the relative solubility and chemical stability of the colouring matters. When they disappear the colouring matter is found deposited in the nearest absorbent glands, where it may be found after death. The absorption of the colouring matter is rarely so complete as not to leave some traces behind.

Tattoo markings may be removed artificially; but if the pigment be deep in the skin, a cicatrix will be left in the spot where the marks existed. An experiment was made by Tardieu on a prisoner who had a crucifix tattooed with Indian ink on his fore-arm. After several applications of acetic acid, potash, and hydrochloric acid, a crust fell off at the end of fourteen days, leaving only a flat scar, without a trace of the original design. Escharotics will, of course, cause the disappearance of tattoo marks; but their place will be indicated by a permanent scar, sunk more or less below the level of the skin. The claimant in the Tichborne case has such a scar above the left wrist; and he has a very peculiar one on the left shoulder, which several insertions of vaccine matter at points equidistant would be likely to produce. This scar occupies the place of the issue of three years' standing which Roger Tichborne had on the left shoulder; and it is therefore probable that it was intended to represent it.

Of tattoo marks, then, we may say that most of them are indelible; some disappear partially; a few entirely; and that if, in a dead body, these marks have disappeared, the colouring matter may be found in the nearest lymphatic glands.

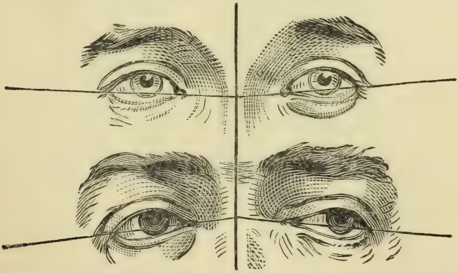
Rules for examining scars.—Place the scar, if possible, in the bright light of the sun, and, in the case of small and delicate scars, use a lens. Measure the scar carefully with compasses, and note its exact dimensions. Record the form and colour of the several parts of which it consists. Redden the surrounding skin by blows or friction. Note whether it is on a level with, or sunk beneath, the surrounding surface; and whether it moves with the skin or remains fixed.

Identification by photographs.—Photographs may mislead when used to represent the whole figure, inasmuch as the limbs, hands, and feet are not all in focus. But they may render great service when we are dealing with the fixed features of the face, though the expression is less to be relied upon, for it is not quite the same in any two photographs taken by the same artist. Even these may vary according as they are in light or in shadow. In the Tichborne case photographs of Roger Tichborne, of the Claimant, and of members of the Orton family, were all used at the trial; and served to show that the Claimant's face differed widely from that of Roger Tichborne taken twenty years before, and also that the Claimant bore a nearer resemblance to members of the Orton family than to Roger.*

We will indicate some of the obvious uses of photographs.

1. *The eyes.*—The colour of the eyes and the direction of the

Fig. 1.



line which joins the inner to the outer canthus, as well as the relative position and shape of the brows, are correctly indicated by

* The illustrations in figures 1, 2, and 3 were executed under the direction of Mr. Piercy, the portrait painter, author of 'A Crucial Test in Cases of Disputed Identity,' with illustrations, 1873.

photographs. Light blue and grey eyes print light, and hazel and brown eyes have a darker tint. By lines drawn through the inner and outer angles of the eyes and made to meet in the median line, we can determine whether the eyes have an upward or downward direction. All these points are well illustrated by the photographs produced in the Tichborne case. The iris in the upper of the two figures (Fig. 1, p. 17), by its light tint, confirms the evidence of witnesses that the eyes of Roger were blue, while that of the lower figure, by its uniform dark colour, corresponds with the dark slate colour of the eye of the Claimant. In this same figure the lines drawn through the corners of the eyes indicate by their upward and downward direction a very important difference between the two persons. The photographs also show marked differences in the eyebrows. Those of Roger Tichborne are wide apart and singularly well-defined, while those of the Claimant are much nearer together, and of ill-defined outline.

2. *The ears.*—There are certain peculiarities in the ear, which may be deemed decisive. One of them consists in the absence of a pendulous lobe, and the firm adhesion of the point to the angle

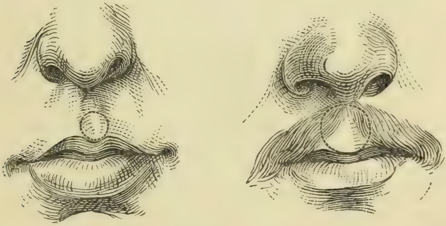
Fig. 2.

of the jaw; a second, in smallness or largeness of size; a third, in its direction relatively to the profile of the face; a fourth, in the rounded or angular outline, and the relative size and shape of its component parts. With the exception of the lobe of the ear, none of these peculiarities admit of being changed by any manipulation, such as the use of weights, or tension, and it is

well known that that part is not greatly altered as the body grows and fattens. If artificial means were used to lengthen the lobe, they could not fail to be detected. The differences between the ears of Roger and the Claimant afford evidence which it is no exaggeration to term "startling." The ear of the Claimant is longer by one-third, the greater length being largely due to the detached pendulous lobe, which in Roger Tichborne did not exist. The dotted lines make the difference between the two ears very apparent. Judging by the published photographs, the ear of the Claimant closely resembles in size and shape that of George Orton, senior, and in size that of George Orton, junior.

3. *The nose and mouth.*—These features, taken separately and together, admit of very marked contrasts. This fact, too, is well illustrated by the photographs produced in the Tichborne case. The nose of the Claimant, with which the lips may be said to harmonize, is "a narrow one in a fat face;" that of Roger "a broad one, with inflated nostrils, in a thin face." The central groove which joins the nose to the upper lip is narrow in

Fig. 3.



the Claimant, wide in Roger—a difference well shown by the dotted circles in the figures. The two mouths are also quite different in character. The comparison, then, which these photographs enables us to institute between the face of Roger and that of the Claimant, leaves no possible room for doubt that the actual personal appearance of the Claimant is not such as Roger Tichborne could have presented after the lapse of twenty years.

Identification by stature and girth.—In the Tichborne case these points came into play. Arthur Orton's Register Ticket, issued when he was 18, shows that he was 5 feet $9\frac{1}{2}$ inches in his shoes, or 5 feet 9 inches in his stockings. The Claimant, carefully measured in his stockings in prison, was also 5 feet 9 inches.

If, then, Arthur Orton stopped growing at 18, he and the Claimant might be one and the same person. But as men, one with another, grow two inches by the time they reach 30, there is a strong probability in favour of Orton having grown taller, and therefore against the Claimant and Orton being one and the same. In the case of Roger Tichborne, the Carabineer, the stature and girth of the chest were also put in evidence.

Identification by wounds.—In January, 1846, when freshly-fallen snow was on the ground, a robbery was committed at Stigny, in the house of two old men. Next morning several spots of blood were seen on the floor on the left of a chest of drawers which the robbers had forced. Other spots were found on the snow in the direction taken by the robbers when they quitted the house, and always on the left-hand of the footsteps. A shred of membrane was found on the road, which proved to be skin. On searching the neighbourhood, a man was found with his *left* hand wounded. Dr. Lemoine and M. Cœurderoi were appointed to examine him; and they agreed that the wound was probably inflicted about the date of the robbery, and that the piece of skin, judging from its size and shape, had formerly covered the injured part. The accused confessed the crime. ('Annales d'Hygiène,' Jan. 1847.)

Alteration in the colour of the hair.—The question whether hair can be turned from dark to light was raised in Paris in 1832, on the occasion of the trial of one Bénoit for murder. Certain witnesses deposed to having seen him in Paris at 2 P.M. with black hair; while others declared that they saw him at Versailles, at 5 or 6 o'clock the same evening, with fair hair. The colour of the man's hair was jet black, and it does not appear that he wore a wig. The tribunal consulted Orfila, and Michalon, a leading hair-dresser of Paris, as to the possibility of changing the hair from dark to light. Michalon replied in the negative; but Orfila stated that as early as the year 1806 Vauquelin had read at the Institute a *mémoire* on the property chlorine has of giving to black hair all the lighter colours, and even of bleaching it.

This case led to careful experiments by Orfila, and subsequently by Devergie. Orfila examined the mode of turning the hair from light to dark, from dark to light, and from light-red or chestnut to other shades of colour. Devergie limited himself to the verification of Orfila's experiments on the effect of chlorine.

Change from light to dark.—The following methods have been adopted:—

a. Charcoal and grease.—This soils the fingers; and on placing

a lock of the hair in hot water, the grease swims, and the charcoal falls to the bottom.

b. Salts of bismuth, lead, and silver.—The hair, freed from its oil by liquor ammoniæ, is moistened with a solution of one or other of these salts, and then, for a quarter of an hour, with sulphuretted hydrogen water. The black sulphides thus formed may be detected by steeping a lock of the hair in dilute nitric acid, and testing for the base. More than one of our photographic processes would effect the same change.

A mixture of litharge, chalk, and lime, in nearly equal proportions dissolved in water (the *Tinctura Pompeiana* of the shops) was found very effectual. The hair was kept moist with it for three or four hours, and then allowed to dry. The chalk and oxide of lead were next removed with dilute acetic acid, and, lastly, the hair was rubbed with yolk of egg. The colour of the hair was thus effectually changed without injury to its texture. By steeping a lock of the hair in dilute nitric acid, the chalk is dissolved with effervescence, and, with the lead, converted into a soluble nitrate. Nitrates of calcium and lead remain in solution.

Change from dark to light.—The results of numerous experiments made by Orfila and Devergie with solutions of chlorine may be thus summed up. Black hair is changed to various shades of chestnut, blond, yellow, and yellowish white, by being steeped, or washed, a longer or shorter time in solutions of chlorine of different strengths. Less marked effects are produced by combing the hair with that fluid. The chlorine is readily detected by its odour, even after washing the hair as many as fifty times with water; while the tint is peculiar, by no means uniform, and not easily confounded with any natural colour; and the hair itself is hard, stiff, and brittle. (These results are in strict accordance with those of my own experiments)—(G.). Better results are obtained with nitric and nitro-muriatic acid, which, diluted with 50 times their bulk of water, impart a golden tinge to dark hair, without apparently injuring its texture. Peroxide of hydrogen has also been largely employed by hair-dressers for this purpose. All these processes occupy time; and the fraud is easily detected by chemical tests; by allowing the hair to grow; or even by stripping the person, and comparing the hair of the head with that of other parts.

The hair undergoes marked change of colour in the course of some processes of manufacture. In turning rollers, for instance, out of the wood known as "green ebony," light hair assumes a green tint; a similar change results from working in an atmosphere containing finely-divided copper.

The effect of sudden and violent emotions of fright and grief in turning the hair grey is well known; and a like change may be produced by disease and other obscure causes. In a case related by Dr. Gordon Smith, a complete change of colour in the hair of the whole body took place in a girl thirteen years of age in a single night, without previous indisposition or emotion; and Dr. Anstie ('Neuralgia and its Counterfeits,' p. 94), has shown that during attacks of facial neuralgia, the eyebrows and hair of the side affected sometimes turn grey, and even white, but resume their usual colour when the pain ceases. These changes in the colour of the hair are sometimes permanent, but the colour may be restored. When the hair of the head is the seat of the change, it is sometimes limited to certain portions only.

Identification by footprints.—It often happens that footprints are found on the soil, or the mark of a blood-stained foot on the floor of the spot where a bloody assault or a murder has been committed; and it may be of importance to compare the marks with the naked feet or shoes of the person suspected of the crime. As regards prints of the naked foot in the soil, a question naturally arises as to whether they can be taken as exact measurements of the foot itself, inasmuch as they must needs vary with the position and pressure of the foot and the character of the soil. But when the impression is that of a foot resting firmly on a tenacious soil, a comparison with the foot of the suspected person may be made with confidence; for it is highly improbable that the foot should yield the same mould in any two persons. When the feet of a suspected person present some notable peculiarity or deformity, the inference drawn from the comparison with the print gains greatly in force. Ogston* has figured marks of different size and shape made by the same foot in running, walking, and standing. This shows the necessity of carefully comparing the impressions left on the soil with those made by the suspected person under similar conditions. In order to preserve footprints for future reference, it has been recommended by Hugoulin to heat the foot-prints with a hot iron or chafing-dish, and dust powdered stearin or paraffin over them. It is easy by the fusion of the stearin to obtain an accurate cast of the print.

Footprints in snow may be preserved by taking a cast of them in gelatine.

The marks of naked feet on floors may require to be cut out for future reference.

The impressions left by shoes must be treated with like caution;

* 'Lectures on Med. Jurisp.,' 1878, p. 63.

but the original form of the shoe, aided in some instances by the position of patches or nails, may afford very important and even conclusive evidence, as in a case related by Sir Walter Scott, in which the murderer of a poor imbecile girl was discovered and identified by the marks of the shoes of the culprit left on the clay floor of the cottage during the death struggle.

Mind and memory.—In the Tichborne case, as in that of Martin Guerre (p. 42), questions relating to the mental faculties, and especially the memory, played an important part. In the first-named case considerations based on the facts brought out at the trial are at least as conclusive against the Claimant as the person, stature, and physical marks. The life the Claimant led in Australia was not such as to raise the question of the possible effect of hardship and exposure, whether on body or mind. There was no emaciation of body, but the very reverse, and no failure of mental power. He laid claim to an excellent memory, and the most plausible parts of his case depended on its exercise; and the fact of his using this, his good memory, whenever its employment promoted his views proved his glaring misstatements as to matters in which he had received no instructions from others to have been the simple result of ignorance. The same memory that claimed to recollect the name of a dog, or the number of a trooper's horse, could not have failed when tested with the Christian names of his mother, the handwriting of his father, his place of birth, his Paris residences, the companions of his childhood and youth, the college where he was educated, the studies he pursued, the examinations he passed, the relatives in whose houses he was always a welcome guest, the agent with whom he was in constant correspondence, the lawyer who made his will, the friends who helped him, the gallant soldier who gave him his commission, and his long, painful correspondence with the mother of the lady he would have made his wife. Nor did the defendant profess to have forgotten any circumstances connected with the lives of Roger Tichborne and his relatives. Roger's mother signs her Australian letter H. F. Tichborne. He does not say that he has forgotton her Christian names, which Roger knew well, but for *Henriette Felicité* he substitutes the homely English names, *Hannah Frances*. Roger took leave of his dying grandfather, Mr. Seymour, at Bath. The Claimant does not pretend to have forgotten the event, but shifts the scene to Knoyle. It was therefore of the very essence of the Claimant's case that he should display a tenacious and accurate memory. It was by the pretended exercise of it that he gained all his adherents. To admit the loss of it would have been fatal to his case.

Roger Tichborne's native language was French. He continued

to speak it in France up to the age of 17, and frequently in England up to the age of 25. He acquired English later, and spoke it to the last with a French accent. The Claimant could not speak or read French; but he spoke Spanish as a man who had spent eighteen months in South America might be expected to do. Assuming, again, the identity of the Claimant with Roger Tichborne, had anything occurred to utterly destroy his knowledge of French? There is but one answer. It had not. The Claimant spoke Spanish years after he had acquired it. What reason, then, could there be for his having altogether forgotten French if he had ever known it? The Claimant was singularly tenacious of the habits he had formed. We may therefore assume that he would have retained some trace of the strong French accent with which Roger Tichborne always spoke English.

One other question relating to the identity of the Living remains to be examined, viz., *What degree and duration of light are needed for identification?* That a very short duration of a brilliant light suffices for this purpose is shown by the case of a lady, on her way from India, who awoke on a dark night, and heard some one stirring in her cabin. A sudden flash of lightning enabled her to see distinctly a man rummaging one of her trunks, and so to discern his features as to identify him next morning. Some of the stolen things were found upon him, and he acknowledged the theft.*

In the following case, the question arose whether the light of a pistol-flash would suffice to discover the face of the person firing.

The Sieur Labbe, on a dark night in May, 1808, was riding with the widow Beaujean, attended by a servant on foot. The servant was wounded in the hand by a gun fired through a hedge bordered by a ditch; and both he and his master swore that they recognised the assassin by the light of the discharge. An accused party who was arrested, tried, and condemned to death, appealed to the Court of Cassation; and Gineau, Member of the Institute, and Professor of Experimental Physics in the Imperial College of France, was consulted as to the possibility of identification in the manner described. Accordingly, Gineau, his son, Professors Dupuis and Caussin, and others, stationed at different distances, to witness the effect, caused several primings to be fired in a dark room. The light though strong, but fuliginous, was so transient that "it was scarcely possible to see distinctly the form of a head, and that of the face could not be recognised." The experiments were then repeated in the court-yard of the college, the gun being loaded

* Montgomery: 'Cyclopædia of Pract. Med.,' art. Identity.

with powder, but with the same results. The sentence was reversed.*

These experiments did not convince Foderé, who thought that if the night were dark, and the persons within six, eight, or ten feet of each other, identification was possible: and the results are certainly at variance with the opinions of persons accustomed to the use of firearms, as well as with our own experiments. We repeatedly recognised the face of a friend by the discharge, in the dark, of a gun close at hand (G.). It may also be reasonably contended, that under the excitement of surprise or fear a person might have a quicker and more distinct perception than an experimenter. The question, then, is one which however well illustrated by these as well as by carefully-planned experiments as to the duration and amount of light requisite for the perception of known and unknown objects of different size and colour and at varying distances, admits of satisfactory solution only by collecting cases of this class.

The following case occurred in England in 1799:—One Haines was indicted for shooting at Edwards, Jones, and Dowson, Bow Street officers, on the highway. Edwards deposed that, in consequence of several robberies near Hounslow, he, with Jones and Dowson, set off in a post-chaise one dark night in November, and were attacked near Bedfont by two persons on horseback, one of whom stationed himself at the horses' heads and the other at the door of the chaise. By the flash of the pistols he could distinctly see that the man at the chaise-door rode a dark-brown horse, between thirteen and fourteen hands high, of a very remarkable shape, having a square head, and very thick shoulders, and altogether such that he could pick it out of fifty horses: he had since recognised it. He also perceived by the same flash of light that the man had on a rough shag-brown great-coat.†

A few similar cases have occurred in England; and there is a French case to the same effect in the Introduction to Foderé's 'Treatise' (note, p. 28).

II. IDENTITY OF THE DEAD.

After death by accident or violence, and in cases of exhumation, the medical man may be called upon to assist in identifying the entire body; to reconstruct one that has been cut to pieces, and the parts scattered; or to examine a skeleton or parts of it, in

* Quoted by Beck from the 'Causes Célèbres.'
† Montgomery: 'Cyclop. of Pract. Med.,' art. Identity.

order to determine the sex, age, and probable stature of the person to whom it belongs.

By careful examination he may ascertain the sex, form some judgment of the age, and even guess at the trade or occupation by the muscular development, the skin of the palms of the hands and the nails (indicating hard work, or the reverse), and the presence or absence of tattooing so common in soldiers, sailors, and criminals, so rare in others. Stains on the hands or clothes may also help to determine the employment.*

The following are examples of successful identification:—

Dupuytren identified a murdered man chiefly by a malformation of the hip-joint; and by a like deformity MM. Laurent, Noble, and Vitrey a corpse buried in a cellar at Versailles three years. The body of Maria Martin was identified eleven months after her death by the absence of certain teeth from the upper and lower jaw, and by signs of inflammation, with extensive adhesions of the pleura, answering to an attack of inflammation of the chest, from which she was proved to have suffered shortly before her mysterious disappearance. A doubtful case, tried at Edinburgh, was decided by a dentist, who produced a cast of the gums. The scanty remains of the body of the Marchioness of Salisbury, discovered in the ruins of Hatfield House, were also identified by the jaw-bone having gold appendages for artificial teeth; and the identification of the body of Dr. Parkman (*see* p. 47) was assisted by the very peculiar formation of the jaw, and the correspondence of part of it with a cast taken by a dentist.

The body of Harriet Lane, the victim of Wainwright, though much decomposed after twelve months' interment, was identified chiefly by the presence of an old scar on the right leg caused by a burn with a red-hot poker.

In some remarkable instances an imperfect sort of identification has been effected after long interment. The real burial-place of some distinguished person has become a matter of dispute, and a coffin, such as was likely to have been used, has been discovered containing the remains of a body. In such cases, when the interment took place several centuries before in a leaden coffin or wrapper, the soft parts, though retaining their form at the moment of exposure, disappear at once as a fine dust. But when the interment is more recent, the body may be completely identified. The finding of the remains of Henry IV. in Canterbury Cathedral, after the lapse of nearly four centuries and a half,† is an example of the first class of cases; the identification

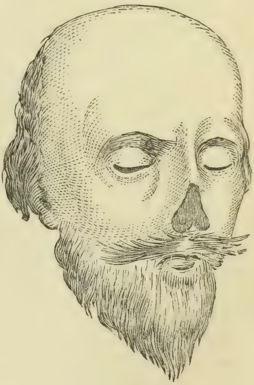
* See this subject treated in detail in the Manual of Briand and Chaudé.

† See Felix Summerly's 'Handbook for Canterbury.'

of the remains of Charles I., after 165, and of the patriot Hampden, after 185 years, of the second class.

Identification of Charles I.—The face of the King, though disfigured, bore a striking resemblance to the portrait on coins, busts, and paintings, and the fourth cervical vertebra was found smoothly divided transversely. As this case is an excellent illustration of the condition, after 165 years, of a body suddenly deprived of life, embalmed and interred in lead, the following brief particulars are added:—On removing part of the lead coffin an inner coffin of wood, much decayed, was exposed, and within this the body wrapped in cere-cloth, into the folds of which an unctuous matter, mixed with resin, had been poured, so as to exclude the air. The coffin was quite full, and on removing the covering from the face, the skin was found dark and discoloured, the forehead and temples well preserved, the cartilage of the nose gone, the characteristic pointed beard perfect, the left ear entire, and the left eye open and full, though it vanished on exposure. The head was found loose, and was easily taken out and held to view. It was heavy and wet, with a liquid that gave to writing-paper and linen a greenish-red tinge. The textures of the neck were solid, and the back of the scalp was perfect and of a remarkably fresh appearance. The hair of the head was a beautiful dark brown, that of the beard of a redder tint. The divided muscles of the neck were considerably retracted, and the smooth surface of the divided fourth vertebra was visible.

Fig. 4



A reduced copy of the engraving which accompanies this description is annexed.*

In the same vault in which Charles I. was interred, Henry VIII. had been deposited. The leaden coffin, enclosed in a thick elm case, appeared to have been beaten in so as to leave an opening large enough to expose

* 'An Account of the Opening of the Tomb of Charles I.' in Sir Henry Halford's 'Essays and Orations.' The bodies of William Rufus, Henry I., Richard I., King John, and Edward I., have at different times been more or less completely identified.

a mere skeleton of the King, with some beard upon the chin. The body had then been interred 266 years.

The search for the body of Hampden was made on the 21st of July, 1828, in the presence of Lord Nugent and others, in Hampden Church, Bucks. The coffin-plate being corroded, the coffin selected for examination was assumed to be his from its position near the tablet erected to his wife. It was of lead, and enclosed two wooden ones, of which the inner one was filled with sawdust. The body was tightly wrapped in three layers of cloth. The abdomen had fallen in. The face, white and marbled with blood-vessels, showed the upper part of the bridge of the nose, eyes but slightly sunk, auburn hair six inches long, strong whiskers, and some beard. The upper teeth were perfect, and those that remained in the lower jaw sound. The skull was well formed, and the forehead broad and high. The arms were muscular, the left perfect, but the right hand was detached, the bones of the arm having been sawn through. Several small bones of the hand, but no finger-nails, were found in a separate cloth. The nails of the left hand were entire. The socket of the left shoulder-joint was white; but the socket of the right shoulder was of a brownish tint, and the clavicle hung loose and detached from the scapula. The body measured 5 feet 9 inches, and was strongly built and muscular. The exhumation confirmed the account of Hampden's death as given by Sir Robert Pye, who married Hampden's eldest daughter, and, at the same time, went some way to explain Lord Clarendon's account of the shattered shoulder as the true cause of death. The dislocated shoulder was probably caused by a fall from his horse.*

A recent and most interesting case of identification is that of the great traveller, Livingstone. An ununited fracture of the humerus, the result of the bite of a lion, was sufficient identification in the case of the body of a European brought from the interior of Africa; coincidence being here quite out of the question.

Identification after very long periods of time is only rendered possible when the air has been excluded by close-fitting wrappers and sealed coffins. How the work of identification is interfered with by the march of putrefaction under ordinary circumstances of interment, and how it may be exceptionally assisted by conversion of the body into adipocere, will be shown when treating of *Putrefaction*.

To the preservation of the bones it is impossible to set any limit

* 'Annual Register' for 1828, Chronicle, p. 93.

of time. Those of King Dagobert, disinterred from the Church of St. Denis, after 1200 years, others from Pompeii after 1800, and others, as parts of Egyptian mummies full 2000 years old, attest their permanence. There is, therefore, no medico-legal case in which they would not be found in a state fit for examination.

The cases of mistaken identity in the living have their parallels in the dead, as the following case will show :—

A resurrection-man was tried for raising the body of a young woman from the churchyard of Stirling, nine weeks after death. It was identified by all the relations, not only by the features, but by the left leg being shorter than the right. The jury was convinced that the *libel was proven*, and gave a verdict accordingly. "Now I am certain that this was not the body of the woman who was taken from the churchyard of Stirling, but one that, at least six weeks after the time libelled, was buried in the churchyard of Falkirk, from which she was taken by this man, who also took the other for which he was tried; she also was lame of the left leg : thus, though guilty of the offence laid to his charge, he was found guilty by a mistake of the *corpus delicti*."—(Dunlop, note to Beck's 'Medical Jurisprudence.')

Cases illustrative of the possibility of dead persons being mistaken for living ones, not merely by acquaintances and friends, but by parents and near relations, are recorded by Smith, and by Dr. Cummin, in his lectures.—('Medical Gazette,' vol. xix.)

Calculation of stature.—If we are dealing with an entire skeleton, we may calculate the stature of the person to whom it belonged by adding about an inch-and-a-half for the soft parts. If the bones are detached, they should be laid out as nearly as possible in the natural position, and then measured, making allowance, as above, for the soft parts.

It is commonly stated that, when the arms are stretched out horizontally, the line from one middle finger to the other is equal to the height. This, though inexact (and less true in women than in men), may be used to determine roughly the stature of a body of which only the bones of an arm are forthcoming. By doubling the length of the arm, adding twelve inches for the clavicles and an inch-and-a-half for the sternum, as suggested by Dr. Taylor, a guess may be made at the stature.

M. Sue, more than a century ago, collected data for calculating the stature from the length of the extremities.* He measured a subject of medium height, chosen as well proportioned. His

* 'Sur les Proportions du Squelette de l'Homme.' Mémoires présentés à l'Académie Royale des Sciences, tom. ii. 1755.

measurements, reduced to English feet, inches, and lines are given in the following table: the first three lines of which show the results of one measurement; the last two of averages:—

Age.	Body.			Trunk.			Upper Extremity.			Lower Extremity.		
	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.
1 year . .	2	0	0	1	2	5	0	9	7	0	9	7
3 years . .	2	11	3	1	8	4	1	3	0	1	3	0
10 years . .	3	1	0	2	1	7	1	8	4	1	9	11
14 years . .	4	10	8	2	5	11	2	4	1	2	4	10
20-25 years.	5	8	2	2	10	1	2	8	0	2	10	1

According to M. Sue, towards the 20th, and from that to the 25th year, the upper border of the symphysis pubis forms the exact centre of the body, and so continues till in old age the spine becomes curved. Before twenty, the centre of the body varies according to the age.

But Orfila, by measuring both the subject and the skeleton,* showed that Sue's statements must be received with caution. Thus, of 44 males (with 4 exceptions, adults), only 7 had the length from the vertex to the pubes exactly equal to that from the pubes to the sole of the foot; while in 23 instances, the former measurement exceeded the latter; and in 14 fell short of it. The greatest difference on either side was $2\frac{1}{3}$ inches English. Again, in not one out of 7 females were the above measurements equal; the upper half of the body was longest in 6, shortest in 1. The males on an average were longer from the vertex to the pubes by more than $\frac{1}{3}$ inch, the females by $1\frac{1}{6}$ inch.

On examining the tables more closely, and bringing together the instances in which the length from the vertex to the pubes happens to be the same, we have found a considerable difference in the length from the pubes to the sole. Of fifteen males measuring 2 feet 9 or 2 feet $9\frac{1}{2}$ inches from the vertex to the pubes, one measured as little as 2 feet 7 inches from the pubes to the sole, while another measured 2 feet $11\frac{1}{2}$—a difference of $4\frac{1}{2}$ inches. Again, of five females, in whom the upper measurement was 2 feet $6\frac{3}{4}$ to 2 feet 7 inches, one measured a little more than 2 feet 4, the other less than 2 feet 8—a difference of nearly 4 inches (G.).

So that in using Orfila's measurements, we might be in error

* 'Traité de Médecine Légale,' tom. i. p. 105.

to the extent of 4 to $4\frac{1}{2}$ inches. His measurements of the skeleton exhibit deviations still more remarkable; for in one instance in which the upper part of the body measures 3 feet $1\frac{1}{2}$, the lower part measures only 2 feet 8—a difference of $5\frac{1}{2}$ inches; and, in another, in which the upper measurement is 2 feet $5\frac{1}{2}$, the lower measurement is 2 feet $11\frac{1}{2}$—a difference in the opposite direction of 6 inches.

M. Sue's facts, then, are too few, and his statements too general; and even the more numerous and exact measurements of Orfila, if used to determine the stature, might lead to serious error.

Orfila's measurements of the cylindrical bones, which he used to calculate the stature of the skeleton and of the living body, also yield, as the subjoined tables show, very uncertain results:—

Stature of the Skeleton, calculated from the Length of the Cylindrical Bones.—(Orfila's second table.)

LENGTH OF BONE.				STATURE.							
	Ft.	In.	Lin.	Max. Ft.	In.	Lin.	Min. Ft.	In.	Lin.	Difference. In.	Lin.
Humerus (6 obs.)	1	1	0	6	1	3	5	9	9	3	6
Ulna 7 "	0	10	8	6	1	3	5	5	0	8	3
Femur 7 "	1	6	1	6	0	0	5	7	0	5	0
Tibia 7 "	1	3	0	5	10	6	5	5	0	5	6

So that for the same length of cylindrical bone we may have a variation in the stature of the skeleton of from three and a half to eight and a quarter inches.

Stature of the Body, calculated from the same data. (Orfila's first table.)

LENGTH OF BONE.				STATURE.							
	Ft.	In.	Lin.	Max. Ft.	In.	Lin.	Min. Ft.	In.	Lin.	Difference. In.	Lin.
Humerus (19 obs.)	1	2	6	5	8	1	5	4	6	3	7
Ulna 14 "	0	10	8	5	10	10	5	5	8	5	2
Femur 12 "	1	5	9	5	9	8	5	4	6	5	2
Tibia 11 "	1	2	5	5	9	8	5	4	6	5	2

Here, then, for the same length of cylindrical bone, we have a variation in stature of from more than three and a half to more than five inches.

This minute analysis of Orfila's tables is rendered necessary by the undue importance he himself attached to them; for he says, "we are certain that it will be possible in the greater number of cases, on consulting these tables, and on having regard especially to the lengths of the femur and humerus, to arrive sufficiently near the truth." This false confidence arose from his not having made a proper use of his own figures; for it is obvious that, with such variations between the maxima and minima, calculations based only on averages cannot be applied to individuals with any degree of certainty. Dr. Henri Bayard, in three instances, in which the only parts of the body left were the bones, applied Orfila's data; in two unsuccessfully, but in the third, with a success which is obviously due to a coincidence.

The following table shows the average measurements in English feet, inches, and lines, obtained from 44 male and 7 female subjects.

	Stature.	Vertex to Pubes.	Pubes to Foot.	Upper Extremity from Acromion.	Femur.	Tibia.	Fibula.	Humerus.	Radius.	Ulna.
Male .	5 6 6	2 9 6	2 9 0	2 5 6	1 5 8	1 2 7	1 2 2	1 0 5	0 9 5	0 10 2
Female	5 1 0	2 7 1	2 5 11	2 2 8	1 4 6	1 1 9	1 1 5	0 11 7	0 8 8	0 9 9

According to Humphry * the following stated percentages are the average proportions of the long bones in the adult European skeleton. Taking the full stature as 100, the spine measures 34·15; the humerus, 19·54; the radius, 14·15; the femur, 27·51; the tibia, 22·15.

AGE.

The law defines, with much minuteness, the privileges, immunities, and responsibilities that belong to the several periods of life. The medical man, however, is not often required to give evidence on this point; and the occasions for so doing will diminish as our registration of births becomes more complete.

It is chiefly as a preliminary to complete personal identification that the question of age is important, and, like the general question, it divides itself into two parts. 1, *The Age of the Living;* and 2, *The Age of the Dead.*

* 'The Human Skeleton,' Table IV. p. 108.

I. AGE OF THE LIVING.

Human life has been arbitrarily divided into septennial and decennial periods, and certain ages (the climacterics) have been specified as epochs of unusual importance and danger. These divisions and distinctions are wanting in the precision necessary for medico-legal purposes.

Nor do the averages of Quetelet, based on the ascertained stature and weight of the body at different ages, admit of application to individuals, and the same objection applies to the position of the centre of the body as a test of age; for though it may be stated, in general terms, that at birth it is at the navel; in the adult, at the pubes; for intermediate ages, at intermediate points, nearer to the navel in the infant, and to the pubes in those approaching adult age; this statement is inexact, and especially in women, in whom the thigh bones being shorter, and the trunk longer, than in men, the centre of the body is above the pubes.

The facts relating to the period of puberty in the two sexes, and of change of life in women, also show the little dependence to be placed on these occurrences as indications of age. The extremes are so far apart that the averages cannot be safely applied to individual cases.

We have more precise, though still very imperfect means of fixing the age of younger persons, in the successive appearance of the teeth both of the first and second dentition.

The first set or milk-teeth appear in the following order:—

Central incisors	5— 7 months.
Lateral incisors	6— 9 ,,
First molars	8—15 ,,
Canine teeth	15—18 ,,
Second molars	18—24 ,,

The milk-teeth, then, do not appear at the same age in all infants; while some are born with the incisors above the gums, others have no teeth till the end of the second year; and a few even live several years without a single visible tooth.

Nor do the teeth of the permanent set appear with such regularity in respect of time as to enable us to use the order and date of their appearance as certain tests of age.

The order and probable time of appearance of the permanent set, with the number of teeth existing at each age, is shown in the annexed Table.

AGE.	INCISORS.		Cuspids.	BICUSPIDS.		MOLARS.		
	Central.	Lateral.		Anter.	Poster.	Anter.	Second.	Poster.
7 years.	...	...	...	...	...	4	...	...
8 years.	4	...	...	...	...	4	...	...
9 years.	4	4	...	...	...	4	...	...
10 years.	4	4	...	4	...	4	...	...
11 years.	4	4	...	4	4	4	...	...
12—12½.	4	4	4	4	4	4	...	...
12½—14.	4	4	4	4	4	4	4	...
18 —25.	4	4	4	4	4	4	4	4

As it was thought that the facts of this table might be employed as a standard of comparison in determining the age of children, especially of those employed in factories, Mr. Saunders* selecting the two periods of 9 and 13 years, observed the number of teeth existing at those periods in many hundred children, and obtained the following results:—

Of 457 boys 9 years of age, 219, or nearly one-half, had the number of teeth stated in the table; namely, 4 central incisors, 4 lateral incisors, and 4 anterior molars. Of 251 girls, of the same age, 168, or much more than one-half, had the same number. Taking the two sexes together, 387 out of 708 had the full complement of teeth. The remainder in both sexes consisted of children who, in place of 4 of each kind, had a smaller number of one or the other. In a large proportion, one, two, or three of the four lateral incisors were wanting, and so of the other teeth; and in 52 cases the lateral incisors were absent.

If then, in the columns of the table, opposite the age of 9 years, we substitute for 4, the numbers, 1, 2, 3, or 4, and assert that wherever any of these numbers are found, the child is in its 9th year, our assertion will be borne out in 656 out of 708 cases, or about 13 in 14. In the remaining 52, a child of eight might be mistaken for one of nine years.

The inquiry respecting children who had attained the age of 13, gave the following results:—

Rather less than half the boys, and more than half the girls, and as nearly as possible half of the two sexes taken together, had the full complement of teeth entered in the table as belonging to children of 12½ to 14: by far the majority of both sexes

* 'The Teeth a Test of Age.' By Edwin Saunders.

had one or more of the several orders of teeth : and in 11 instances only were some or other of the teeth wholly wanting. In three cases a child of 13 might have been mistaken for one of 12 to $12\frac{1}{2}$, in one for one of 11, and in another for one of 10. In a vast majority of instances, however, a child having one or more of the several teeth indicated in the columns of the table opposite $12\frac{1}{2}$ to 14 years had completed its 13th year.*

The permanent teeth are not complete till the *dentes sapientiæ* make their appearance. This usually happens from the 18th to the 25th year, but sometimes much later ; and a case is recorded by Dr. Hamilton of a man of 80 who died from the irritation produced by cutting a wisdom-tooth.

Some stress has been laid as a test of age on the white line at the margin of the cornea, known as the *arcus senilis*. As the arcus is occasioned by a deposit of oil-globules, which may take place from causes other than advancing age ; as Mr. Canton reports cases of his own, or on the authority of others, in which it has been present at 42, 34, 33, and even at 28 years ; and as we have ourselves seen it completely formed at 42 and 39, and absent at 79 and 85, it is obvious that this appearance must either be rejected as a test of age, or only used in healthy persons, living or dead, in conjunction with other signs of age (G.).†

All other indications of age in the Living, such as grey or bald hair, and loss of teeth, are deceptive. Cases of premature old age, of unusual vigour at advanced periods of life, and of restoration to the aged of some of the structures and functions proper to an earlier period (*e.g.*, the cutting of teeth and the growth of coloured hair ; the secretion of milk, and the persistence or return of the menstrual discharge), may prevent us from even guessing at the age. On the other hand, the early occurrence of the marks of puberty in both sexes, and the premature or very late appearance of the menses in the female, create difficulties in rightly estimating the age at earlier periods.

II. AGE OF THE DEAD.

In the bodies of persons recently dead, we have the same means of estimating the age as in the living ; and we may learn something from the dissection of the body. Calcareous deposits in the heart and arteries, for instance, afford a strong probability that the subject had reached a mature if not an advanced period of life.

* The results here stated in general terms were given in the first edition of this work in a tabular form.

† On the Arcus Senilis, or Fatty Degeneration of the Cornea. By Edwin Canton, F.R.C.S., 'Lancet,' May 11, 1851.

The state of ossification of the bones of the skeleton provides the best guide to the determination of the age. It would be out of place in a work of this kind to specify in detail the exact periods at which the various bones commence to ossify. For these reference must be had to standard works on anatomy. But the periods at which the ossification of the various parts of the skeleton is usually completed, may be of considerable practical value.

Skull.—The separate bones of the skull are usually all united within a few years after birth. Occasionally, however, the two halves of the frontal bone remain separate through life.

Vertebral Column.—In the *third* year the arch and body of the vertebræ unite, and also the odontoid process and body of the axis. The epiphyses of the spinous and transverse processes commence to ossify about puberty, but are not united to the vertebræ till the age of *twenty-five* or later.

The individual vertebræ of the *sacrum* remain separate till the age of *eighteen*, when they begin to unite from below upwards, the process not being completed till the age of *twenty-five* or later. At a still later period, but subject to considerable variation, the coccyx becomes united to the sacrum.

Ribs.—The shaft and epiphyses of the ribs remain separate till the age of *twenty-five*.

Sternum.—The five segments of the sternum remain separate till the age of puberty, when the lower segments unite. The upper segments unite from the *twenty-fifth* to the *thirtieth* year. The manubrium and body do not unite till extreme old age.

Upper Limbs.—The various centres of the *scapula* unite from the *twenty-second* to the *twenty-fifth* year. The sternal epiphysis of the *clavicle* appears from the *eighteenth* to the *twentieth year*, and becomes joined to the shaft at the age of *twenty-five*.

The head and tuberosity of the *humerus* unite at the age of *five*, and become joined to the shaft at the age of *twenty*. The condyles unite with the shaft from the *sixteenth* to the *eighteenth* year. The superior epiphysis of the *radius* unites with the shaft at from the *seventeenth* to the *eighteenth* year, and the lower epiphysis unites with the shaft at the age of *twenty*. The same holds in respect to the *ulna*.

The epiphyses of the *metacarpal* and *phalangeal* bones unite with their shafts at about the *twentieth* year.

Lower Limbs.—The rami of the pubes and ischium unite about the *seventh* or *eighth* year; the various parts forming the acetabulum from the *sixteenth* to the *seventeenth* year, while the complete ossification of the os innominatum does not take place till the *twenty-fifth* year.

The head and shaft of the femur unite about the *eighteenth* or *nineteenth* year, while the lower epiphysis and shaft remain separate till the *twentieth* year.

The lower epiphyses and shaft of the *tibia* unite in the *eighteenth* or *nineteenth* year. The upper unites with the shaft in the *twenty-first* or *twenty-second* year.

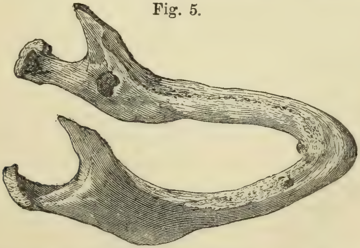
The union of the epiphyses and shaft of the fibula occurs somewhat later.

The epiphyses and shafts of the *metatarsal* bones unite from the *eighteenth* to the *twentieth* year; those of *phalanges* about a year later.

If, then, on examination of a skeleton, or part of one, we were to find that bony union had not taken place at the points above indicated, we should conclude that the individual was under the age specified as that at which such union usually takes place; and at or over that age if ossification is completed. By careful examination of the state of ossification of the various regions, and comparison with more exact anatomical details, the age of the individual may be calculated with a considerable approach to accuracy within the period before the consolidation of the skeleton is complete. After that, that is, beyond thirty, it is more difficult, and attention requires to be devoted more particularly to the signs of senile degeneration.

In old age there is a tendency to ossification of the cartilages of the ribs and larynx. Sometimes the larynx is entirely converted into bone. The bones become lighter, owing to absorption of the osseous plates of the cancelli. Hence the flat bones become thinner, through the approximation of the osseous laminæ. This is seen in the skull, scapula, and ilium. Owing to the same cause, the angle which the head of the femur forms with

Fig. 5.



the shaft becomes reduced. The bones are more brittle, and more or less infiltrated with free fat, which gives them a yellowish

colour and greasy aspect and touch. The sutures of the skull become less distinct or entirely obliterated. The intervertebral discs shrivel, the bodies of the vertebræ become bevelled off in front, and the spine bends forwards.

But the *jaw* is the part which changes most with age. In the fœtus and in early infancy the ramus and body form a very obtuse angle; in middle life, nearly a right angle; but in old age, when the teeth have dropped out, and the alveolar border is absorbed, it reverts to the infantile type. In very old persons the jaw has the characteristic appearance shown in the engraving (Fig. 5, p. 37).

SEX.

This subject, like the foregoing, divides itself into two parts. 1. *The Sex of the Living*; and, 2, *The Sex of the Dead.*

I. SEX OF THE LIVING—DOUBTFUL SEX.

The question of sex may be raised in reference both to infants and adults. In the case of a new-born child, the issue of parents possessed of real or landed property, the right of succession, and, should it die, the disposal of the property, depends on the sex. If a wife, being tenant in tail-mail, is delivered of a son born alive, the husband's right is secured; but the property passes from him if she gives birth to a daughter. This form of succession is termed *tenancy by the curtesy.*

It may be necessary also not merely to ascertain the sex, where that can be done, but, in doubtful cases, to determine which sex predominates; for it appears, on the authority of Coke upon Littleton, that "an hermaphrodite, which is also called Androgynous, shall be heire, either as male or female, according to that kind of the sexe which doth prevail, and accordingly it ought to be baptized."

The question of sex may also arise at a later period, as in the case quoted by Beck, of a young nobleman of doubtful sex, whose parents consulted a medical man whether the education should be that of male or female.

There are three conditions of the organs of generation which may present difficulties to the medical examiner.

1. The organs of a male may resemble those of the female.
2. The organs of a female may resemble those of the male.
3. The organs of the two sexes may be blended.

1. The organs of the male may resemble those of the female (Androgyni). The most common malformation of this sort consists of a small, imperfect, and imperforate penis, a short canal opening at its root, and a cleft scrotum, bearing some resemblance to the clitoris, vagina, and labia of the female. Each section of the

scrotum may contain a testicle, but the testes, one or both, may be lodged behind the external ring. The short canal, or *cul de sac*, which replaces the urethra and opens at the base of the penis, or in the perineum, near the anus, is found to communicate with the bladder. This opening is often enlarged, so as to resemble the vagina; and even to discharge its sexual function. From the position of the opening of the urethra beneath the imperforate penis these persons are called *hypospadians.*

The presence of testicles in the folds resembling the labia, or in the groin; the communication of the opening between the imperforate penis and the anus with the bladder; the absence of any organ corresponding to the uterus; and, in the adult, the absence of menstruation—enable us at once to determine the sex. In most of these cases the build of the body, the muscular development, the voice, the tastes and habits, are more those of a man than of a woman. Many cases answering to these descriptions are on record; and there are preparations, casts, models, and drawings illustrating these malformations in most of our museums. The following case by Mr. W. Loney ('Lancet,' May 7, 1856) is a good illustration:—Jane W———, a lunatic, twenty-eight years of age, was admitted into the Macclesfield workhouse. She excited suspicion by her unwillingness to be washed, and on being examined was found to have a penis two inches long, and the same in circumference, placed on the pubes, just above and between the external labia; with a well-defined prepuce, which could be moved at pleasure, causing a slight erection. Just below this was an opening so small as scarcely to admit the little finger, and a ligamentous band could be felt at about three inches distance from its mouth. The urethra could not be seen, but a catheter was passed into the bladder through this opening. The penis was imperforate. The hair of the head was short and curly, like a man's; the limbs very muscular and hairy; and the voice exceedingly rough and masculine. The mammæ were entirely absent, and there was more hair than usual about the pubes. She had never menstruated. Her taste was so depraved that she would eat old poultices with great delight. She was strong and healthy, and annoyed the young women in the same ward by the display of her amatory propensities.

But there are cases in which an enlargement of the breasts, coupled with a preference for the society of the male, might mislead if the organs of generation were not examined; and in some instances the absence of the sexual passion creates uncertainty.

Sometimes the penis, well or ill-formed, is confined to the scrotum by a peculiar formation of the integuments. This malformation,

with the other deviations from the normal structure just described, occurred in two cases, one a negro, the other a European, of which Cheselden gives engravings; and in the case of a child baptized and brought up as a girl, Mr. Brand, by a slight incision, liberated the restricted parts, and proved to the parents that they had been mistaken.

Another malformation belonging to this division, which might possibly give rise to doubt, consists in a deficiency of the anterior wall of the urinary bladder, and of the corresponding part of the abdominal wall, their place being occupied by an irregular, red, sensitive mass, with the ureters opening upon it. The penis is short and imperforate, and the vesiculæ seminales open in a small tubercle at its root, or on the red and sensitive surface. The testicles are generally well formed, sometimes contained in the scrotum, sometimes to be felt in the groin, or they have not descended. The sexual appetite may be strong, weak, or altogether wanting. Those who have this malformation are called *epispadians.*

2. The female organs may resemble the male (Androgynæ). The malformations belonging to this class are an enlarged clitoris, and a *prolapsus uteri.* In the first case—that of enlarged clitoris—the absence of testicles from the labia, the presence of a vagina and uterus, the occurrence of menstruation—these, singly or combined, render the distinction easy.

Cases of prolapsus uteri involving a question of doubtful sex have been recorded by Sir Everard Home, and Mahon. Home's case was that of a Frenchwoman, who had *prolapsus* evident on inspection: she laid claim to the male sex, and was shown as a curiosity. Mahon's case is that of one Margaret Malaure, exhibited at Paris in 1693, dressed as a man, and alleging that she possessed and could use the organs of both sexes. Several physicians and surgeons certified that she was an hermaphrodite; but Saviard, an eminent surgeon, being incredulous, examined her in the presence of his brother practitioners, and found a *prolapsus uteri,* which he reduced.

3. The organs of the two sexes may be blended.

Many cases of this imperfect approach to true hermaphrodism are on record. In some an ovary has been found on one side and a testis on the other; or the external organs have approximated closely to the female type, the internal to the male, or the reverse.* But there is no case on record of the organs of both

* See the case of Durrje or Derrier in Cummin's Lectures, 'Med Gaz.' vol. xix.; and for cases of the last-named malformation, occurring both in man and animals, the complete and learned paper on Hermaphroditism in the 'Cyclopædia of Anatomy and Physiology.' See also the case of *Levi Suydam*, respecting whom the question arose whether he was a male, and entitled to

sexes perfectly developed in the same person; the nearest approach to this "lateral hermaphrodism" being the case of Catherine Hohmann, referred to in the note at the foot of this page.

In examining cases of doubtful sex, the following points should be attended to:—The size of the organ corresponding to the penis or clitoris, and whether it is perforate or imperforate; the form and mode of attachment of the prepuce; the presence or absence of parts corresponding to the nymphæ; the presence or absence of testicles. If any opening exist it must be carefully examined with a sound, to ascertain whether it communicates with bladder or uterus, or is a *cul de sac;* and inquiry should be made respecting the existence of the menstrual or other vicarious discharge. The general conformation and appearance of the body should also be observed, including the growth of hair on the head, chin and other parts;* the formation of the shoulders and hips; the development of the breasts; the fulness of the thighs; the tone of the voice; and the feeling and conduct towards either sex.

II. SEX OF THE DEAD.

When the entire body is submitted to inspection, there should be no difficulty in determining the sex, except in those rare instances in which the characters of the two sexes are blended; and in these, the sex, which could not be determined during life, may be ascertained by dissection.

But when the question of sex is raised after death, it is generally in reference to the skeleton, or some part of the osseous system, in which the following differences are observable:—

The *bones* of the female are lighter, more cellular, smoother, and less curved, than those of the male; the processes less marked, and the joints smaller. The *skull* of the female is smaller, more ovoid, more bulging at the sides, and longer behind the foramen magnum; the face more oval, the frontal sinuses less strongly marked, the nostrils more delicate, the jaws and teeth smaller, and the chin less prominent. The *chest* of the female is deeper in its antero-posterior as compared with its transverse diameter than in the male; the sternum shorter and

vote as a freeman, or a female ('Amer. Journ. Med. Soc.' 1847); and the very remarkable case of *Catherine Hohmann*, who had the instinct both of the male and female, and who menstruated periodically, and had also seminal emissions containing spermatozoa ('Berlin Klin. Wochensch.,' Dec. 2, 1872, 'Med. Times and Gazette,' June 28, 1873; and 'American Journal of Obstetrics,' Feb. 1876, p. 615).

* The curious case given by Dr. Chowne of an otherwise well-developed female with copious beard and whiskers, cautions us not to attach too much importance to any single sign detailed in the text. For the case itself, and a learned history of similar instances, see 'Lancet,' 1852, vol. i. p. 421.

more convex; the ensiform cartilage thinner, and ossified later in life; the ribs smaller, and the cartilages longer. The *vertebral column* is longer, and the bodies of the vertebræ are deeper in the female than in the male. The neck of the *femur* in the male forms an angle with the shaft of from 125° to 130°, whereas in the female the angle more nearly approaches a right angle. The *pelvis*, however, presents the most striking contrast. The ilia are more expanded and horizontal in the female; the sacrum more concave; the pubes more shallow; the angle formed by the descending rami more obstuse; the pubic arch wider, the tuberosities of the ischia more largely separated; the obturator foramen larger, more triangular, and more oblique; the acetabula wider apart; the entire pelvis more shallow, but larger in its outlets, than in the male. These differences are shown in the annexed engravings; in which A represents the male, and B the female pelvis.

The difference between the male and female skeleton is less strongly marked before the age of puberty.

Fig. 6.

The following table shows the respective measurements of the male and female pelvis at the brim:—

	Male.	Female.
Antero-posterior, or conjugate diameter	4 in.	$4\frac{1}{2}$ in.
Transverse	$4\frac{1}{2}$,,	$5\frac{1}{4}$,,
Oblique	$4\frac{1}{4}$,,	5 ,,

This group of subjects—Identity, Age, and Sex—may be advantageously brought to a close by three cases, one in the living and two in the dead, in one or other of which the question of identity in most of the forms it is likely to assume will receive ample illustration.

1. *The case of Martin Guerre.*—More than three centuries ago (in 1539) two children about 11 years old were married at Artigues, in Languedoc. The husband was Martin Guerre, the wife

one Bertrande de Rois. After the lapse of nine years a son (Sanxi) was born under peculiar circumstances, known only to the parents. Martin, an elder son, lived with his father, but having robbed him, and fearing detection, disappeared, and was not heard of for eight years. In this interval the father died, leaving four daughters under the guardianship of a younger brother, Pierre. The absent Martin enlisted as a soldier, and had for comrade one Arnauld de Tilh (or Dutille) *alias* Pansette, a man of known bad character, who became so intimate with Martin as to possess himself of all his secrets. Martin lost a leg in the wars, and being taken ill, and thinking he should die, gave Arnauld what he had about his person. At the end of the eight years, this Arnauld, thus possessed of Martin's secrets and personal property, and having been mistaken for Martin by some friends of his, presented himself at Artigues, and was at once accepted as the real Martin Guerre by his uncle, sisters, and all his friends and acquaintance, and, most strange to say, by Bertrande herself, who having been warmly attached to her husband, welcomed the new-comer with unfeigned affection, and bore him two children, one of whom died young. Arnauld lived with his comrade's wife, and surrounded by his comrade's relatives, friends, and acquaintance, for three years; when a soldier passing through the village startled Bertrande with the intelligence that her husband Martin, who had lost a leg in battle, was living in Flanders. Bertrande, disturbed but unconvinced, went to a Notary and bade him draw up a record of the soldier's statements; but she took no further notice of them, and continued to live with Arnauld as before. After three years, Pierre, the uncle, quarrelled with Arnauld, and would have killed him but for the interference of Bertrande. Soon after, in consequence of a village quarrel, Arnauld was arrested, and imprisoned at Toulouse, and thereupon the uncle, with other relatives, tried to persuade Bertrande to denounce him as an impostor; but she resolutely refused, and when he was released on bail, received him as before with every mark of affection. But next day, the uncle, pretending to act under a power of attorney in Bertrande's name, arrested Arnauld on a charge of fraud and deception. When the case came on for trial, the uncle alleged that the prisoner was not Martin Guerre, but Arnauld de Tilh, known to many persons in the district from his youth as of bad character. On the part of the prisoner, on the other hand, all the facts connected with his early and complete recognition were adduced, and his perfect knowledge of matters the most trivial and the most secret, backed by Bertrande's upright character, blameless life, and strong affection. Witnesses, 150 in number, were then called, of whom

between 30 and 40 had no doubt of the identity of the accused with Martin Guerre, 50 declared him to be Arnauld de Tilh, and 60, though on terms of close intimacy with both the parties, could come to no conclusion. The son, Sanxi, was then brought forward; and though no likeness could be traced between him and the prisoner, he was pronounced to have the family look, and bear the closest resemblance to the four sisters of Martin Guerre. The Judge, on summing up the evidence, gave sentence against the prisoner, as an impostor, adulterer, and usurper, and condemned him to be beheaded and quartered. But he appealed to the Parliament of Toulouse, which instituted a new inquiry. The prisoner, on being confronted with Bertrande, said he would abide by her decision, and place his life in her hands. Would she swear that he was not Martin Guerre? Bertrande answered "that she could neither swear nor believe it." Thirty new witnesses were then called, of whom 10 swore that the prisoner was Martin Guerre, 7 that he was Arnauld de Tilh; the rest spoke doubtfully. An uncle of Arnauld and some of his friends said they had recognised the prisoner as Arnauld from the first, but assigned reasons for not having exposed him

The evidence of the witnesses as to the personal characteristics of the two men led to the conclusion that there was little resemblance between them. Martin was described as tall and dark, spare in body and limb, with his head sunk between the shoulders, a forked curved chin, a hanging lower lip, a large turned-up nose, an ulcer on the face, and a scar on the brow; while Arnauld was short, thick-set, and corpulent, had a stout leg and no stoop, a different set of features, and scars on the face about which the witnesses could not agree. But the prisoner had double eye-teeth in the upper jaw, a scar on the forehead, the nail of the forefinger of the left hand sunk in the flesh, three warts on the right hand and one on the little finger, all which peculiarities were recalled by the witnesses as belonging to Martin Guerre. Martin's shoemaker deposed that his shoes had to be made a fourth longer than those of Arnauld. Martin, too, was a skilled fencer, which Arnauld was not, and Arnauld could not speak even a few words of Martin's native Basque language. One witness (Jean Espagnol, an innkeeper) asserted that Arnauld had confided to him in the strictest secrecy all the facts relating to his close intimacy with Martin, and consequent knowledge of all his secrets.

The Parliament of Toulouse, found the evidence conflicting. They attached great weight to the spontaneous recognition of Arnauld by those who might be presumed to be the best possible judges, as well as to his admitted resemblance to the four sisters of Martin;

while, on the other hand, the lapse of time in the case of a lad who left his native village when only 20 years of age, added to the hardships and vicissitudes of a soldier's life, would serve, they thought, to explain even marked changes in form and face, and the failure to recollect the words of his native tongue, which, indeed, he might have forgotten before he left his native village. These considerations inclined them to give their sentence in the prisoner's favour. But at this juncture a man with a wooden leg calling himself Martin Guerre, appeared in court. He was immediately arrested, shut up, and secretly examined; when he displayed the same knowledge of facts respecting his village, acquaintances, and family as Arnauld had done; and when confronted with the prisoner, bore the test of cross-examination equally well, but often answering with less readiness, and even less minuteness of detail. The brother of Arnauld had absconded, and refused to appear. The new-comer was then brought face to face with members of the family of Martin Guerre. His sisters, as they entered one by one, glanced at him, threw their arms round his neck, burst into tears, called him their real brother, and asked his pardon a thousand times for having allowed themselves to be deceived; and Bertrande, too, no sooner caught sight of him than she fell on her knees before him, urging in her exculpation of the wrong she had unwittingly done him, the astonishing resemblance between him and the villain who had deceived her, and the readiness with which his own sisters and all the villagers of Artigues had recognised him. The same revulsion of feeling showed itself in all who had borne witness in Arnauld's favour; and the Judges, convinced by the tears and passionate grief of the loving wife, reinstated Martin Guerre in all his rights, and condemned Arnauld de Tilh to be hanged and burnt. Before his execution, the impostor made a full confession of his guilt.*

2. *Case of Houet.*—In the year 1821, Madame Houet, a widow lady, resident at Paris, disappeared; and Bastien, Robert, and Robert's wife, suspected of having made away with her, were

* We have retained this case, with a few slight abbreviations, as it stood in the last edition of this work; and we should have added the Tichborne case, but that we should have found it very difficult to bring it into a reasonable compass. It occupies 13 pages in the appendix to the last (the fourth) edition of this work, to which we refer our readers. The leading facts of that singular case will be found in sufficient detail in the text. We take the opportunity of here pointing out a simple procedure which, if put in practice, would guard against the occurrence of such scandals in future. The Home Secretary ought to be empowered in all such cases as the Tichborne claim, to appoint two or more skilled physicians and surgeons to make a preliminary report on the state of body and mind of the claimant; and unless a fair *primâ facie* case is thus made out, to refuse permission to engage in legal proceedings. Had the Home Secretary possessed and used this power, the Tichborne case could not have been brought into court.

tried before the Court of Assize; but for want of evidence, set at liberty. In consequence, however, of information subsequently obtained touching a body said to have been buried about eleven years in a garden, the remains were so completely identified, and the manner of the death so clearly shown, that the prisoners were convicted and punished.

After excavating different parts of the garden, a workman hit upon a hollow spot, which was found to contain the remains of a human body, reduced almost to a skeleton. A drawing was made of the parts *in situ*. The figure lay on the left side, with the head bent on the neck, the vertebral column curved, and the right fore-arm raised, so that the hand nearly touched the face. The pelvis was turned obliquely upwards; the thigh-bones were raised, and the legs crossed beneath them. The prevailing colour of the remains was yellowish-brown, but the parts in contact with some of the long bones were of a deep-red tint.

The bones were small and delicate, those of the extremities not curved by muscular motion, and the marks of the insertion of the muscles few and faint. Among the bones of the left hand were found a small gold ring, carved in *facettes;* and several small well-formed finger-nails. The skull was small and oblong; the sutures well-knit; the teeth white and well preserved; but three molars were wanting, and one of the incisors was carious. Some light-coloured hair was found, blended with grey hairs. The ossa innominata were largely spread out; the cavity of the pelvis not deep; the anterior part of the sacrum concave; the sub-pubic holes triangular; the cotyloid cavities wide asunder; and the upper opening of the pelvis had the diameter usual in well-shaped females. It was therefore justly inferred that this was the skeleton of a woman.

The third, fourth, fifth, and sixth cervical vertebræ, and right clavicle, were held together by a blackish mass, surrounded by several twists of a small decayed cord, leading to the inference that the deceased had been strangled, an inference fully borne out by the circumstantial evidence.

Several elaborate documents were drawn up by the reporters; of the first of which the following is a *résumé:*—

"1. That these bones are those of a *human* skeleton. 2. That the skeleton is that of a *female.* 3. That she had attained the *age* of from 60 to 70. 4. That her height was about 4 feet 8 or 9 inches. 5. That her hair, which was a bright blond in youth, was mixed with gray at the time of her death. 6. That the hands were small. 7. That during life the bones had suffered no injury. 8. That this woman died of strangulation, and that

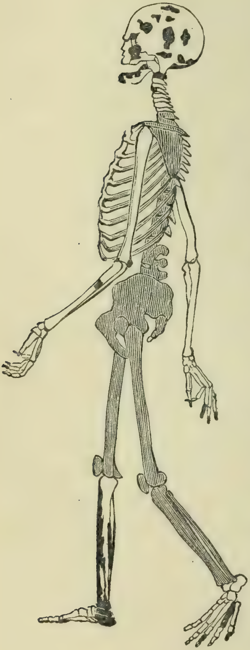
the act was, to all appearance, homicidal; and, 9. That the body must have lain for several years in the earth."

The prisoners, who had been long suspected, were tried, condemned, and sentenced to forced labour for life.

3. *Case of Dr. Parkman.*—Dr. George Parkman, of Boston, U.S., was last seen alive on the afternoon of Friday, Nov. 23rd, 1849, entering the Medical Institution in which Dr. John W. Webster was Lecturer on Chemistry; and it was proved that he went there by appointment to receive money which Dr. Webster had long owed him. Dr. Parkman was missed and could not be found; but on the Friday following his disappearance, in consequence of the suspicions aroused against Dr. Webster, search was made in his laboratory and the places attached to it, which issued in the discovery, in the vault of a privy, of a pelvis, right thigh, and left leg, and some towels marked with Dr. Webster's initials, such as he was in the habit of using. There were also found in the furnace of the laboratory, mixed with cinders, many fragments of bone, blocks of mineral teeth, and a quantity of gold. A tea-chest was also found, which contained, embedded in tan, and covered with minerals, the entire trunk of a human body, the left thigh, a hunting-knife, and a piece of twine of the sort used in the laboratory. On the left side of the chest a penetrating wound was discovered; and to this the death was attributed. These portions of a human body being found in a medical college, it might be alleged that they were parts of a dissected subject; but this was shown not to be the case, for the vessels were free from all trace of the preservative fluid always employed in that college. They contained neither arsenic acid, nor chloride of zinc. It was further proved that the joints had been severed by a man having some anatomical knowledge, and some practice in dissection. The fragments of the body, when put together, fitted accurately. The 3rd and 4th lumbar vertebræ coincided; "the right thigh, on being placed in apposition with the pelvic portion, the bones, muscles, and skin, corresponded perfectly;" so also with the left thigh and pelvis, and the left leg and thigh. The fragments, therefore, belonged to the same body; and it was shown that there were no duplicate members or bones. By putting the parts together, and measuring them, they were found to be $57\frac{1}{2}$ inches long; and adding 3 inches for the length from the outer malleolus to the sole of the foot, and 10 inches from the crown of the head to the base of the 6th cervical vertebræ, the length was brought up to $70\frac{1}{2}$ inches, the exact stature of Dr. Parkman, as proved by his passport. As to the age, Dr. Stone stated

that, judging from the skin, hair, and general appearance, the body belonged to a person from 50 to 60 years of age, and that the amount of ossification of the arteries would indicate that he was nearly or quite 60 years old. Dr. Parkman was about 60. The question of sex was not raised, as the parts of generation were found attached to the pelvis. 35 fragments of bone were found, and among these three which, when put together, made up the greater part of the right half of the lower jaw, and enabled Dr. Wyman to ascertain that the teeth from the coronoid process to the first molar, or bicuspid, were wanting. To obviate this defect, a dentist had been applied to, not long before Dr. Parkman's death, to supply him with mineral teeth. These were found with the *débris* of the bones, in the furnace; and the cast the dentist had taken fitted with great accuracy the very peculiarly shaped jaw of Dr. Parkman.

Fig. 7.



Thus the identification was complete; and, after a long and patient investigation, Dr. Webster was found guilty, and at length confessed the crime. He first struck Dr. Parkman on the head with a heavy stick, and then stabbed him in the chest.*

* This short account is taken from a full Report published at the time. Dr. Wyman exhibited at the trial a drawing of a skeleton with the bones that were found tinted yellow. In the annexed engraving, taken from p. 54 of the Report, these fragments are printed black. The case affords a good example of the reconstruction of a mutilated body.

CHAPTER II.

IMPOTENCE, RAPE, PREGNANCY, DELIVERY.

The subject of sex, having been treated as a means of identification, is here considered in relation to the generative function, and comprises the subjects at the head of the chapter.

IMPOTENCE.

The question of impotence, or incapacity for sexual intercourse, may arise in suits for divorce, in cases of contested legitimacy, and in accusations of rape. The question is not often raised in the case of females, and objection may perhaps be taken to the use of the term impotence in reference to women. But in order to avoid needless multiplication of words, the meaning of the term is here extended so as to embrace both sexes.

Marriage, being a contract, presupposes, as do all other contracts, a free exercise of the will, and ability to fulfil its terms.

The first condition comes in question when undue influence has been brought to bear on either party to the contract, and it is alleged that the person so influenced was of weak or unsound intellect. (*See* Unsoundness of Mind, Imbecility, and Dementia.)

The second condition—ability to fulfil the terms of the contract —may fail through physical defects; but in order to establish a legal ground for divorce, corporeal imbecility must have existed *before* the marriage, and be irremediable. The person of the husband may, therefore, have to be examined: but if he is not forthcoming, that of the wife, in order to find confirmation of the alleged impotency. This happened in a case decided adversely to the husband in the ecclesiastical court. A certificate was produced, twelve years after marriage, that the wife was *virgo intacta*, though *apta viro*, and that her health had suffered; the husband had also twice confessed his incapacity, had not given in his answer, had removed into France, and had refused to undergo examination.

Impotence will have to be considered under two heads of— 1. Impotence in the *Male*, and 2. Impotence in the *Female*.

I. IMPOTENCE IN THE MALE.

The causes of impotence may be—1. *Physical,* 2. *Mental.*

1. The *Physical Causes* are—*a.* Too tender or too advanced an age. *b.* Malformation or defect of the penis. *c.* Defect or disease of the testicles. *d.* Constitutional disease or debility.

a. Age.—The earliest age recognised by law for the marriage contract is 14 in the male, and 12 in the female. But the ecclesiastical courts look rather to the "habit, strength, and constitution of the parties," or whether they be *habiles ad matrimonium;* and the common law will hold infantile marriages, duly solemnized, valid, "when the parties on reaching the ages just stated, do not demur to the contract."

The age of puberty, in both sexes, is subject to great variation. It is usual to recognise 14 years as its earliest advent in the male; but it may first show itself much later than this: and many cases are recorded of large development of the sexual organs in childhood. Casper alleges that the power of coition begins earlier and ceases later than that of procreation; and, that in Germany, the date for the one is about the thirteenth, and for the other from the fifteenth to the sixteenth year (Vol. iii. p.258).

The signs of puberty are to be sought for in the build of the body, the voice, the growth of hair on the pubes, and the development of the organs of generation. If all the genital organs have the usual manly development, it is safe to infer that complete sexual intercourse is possible.

But impotence may arise from old age as well as from immaturity; hence one of the questions raised in the celebrated Banbury Peerage Case—At what age do the powers of procreation cease?

In this case, tried in the House of Lords, and decided in 1813, the principal argument urged against the claimant was that the ancestor under whom he claimed was eighty years old at the date of the birth; but Sir Samuel Romilly, after stating that the law of England recognises no age, from seven upwards, to which is denied the privilege of having children, cited, as medical authorities, Dr. Gregory, of Edinburgh, and Haller; of whom the first-named says that instances have been cited of the retention of sexual vigour by men upwards of a hundred years old, and that it is not to be doubted that fathers of eighty are not uncommon; while the second pronounces a man of ninety to be capable of procreating. Parr, he added, became a father in his one hundred and fortieth year. Lord Erskine, following on the same side, cited the case of Sir Stephen Fox, who married at seventy-seven, and had a child born to him when he was seventy-

eight, twins in the following year, and a fourth child when he was eighty-one. The Attorney-General, Sir Vicary Gibbs, who opposed the claimant's title, tacitly admitted the weakness of the objection on the score of age by shifting his argument to the more secure ground, that age, though not a proof of impotency, is evidence of it. "The probability of the Earl's begetting a child at eighty is very slight, and it is not increased by the appearance of another child two years later. Instances have been adduced of these extraordinary births, but none have been cited in which a man at eighty-two, having begotten a son, had concealed the birth of such son." It is clear, then, that no limit is fixed by law, or can be assigned by science, at which the power of procreation ceases. Old age, provided it be a robust old age, is obviously no impediment to procreation; and there was ample evidence of Lord Banbury having taken strong exercise till within a short period of his death.*

The finding of spermatozoa in the bodies of several men above eighty years of age, and of one æt. ninety-six, lends confirmation to the facts founded on the fruitful marriages of old men.†

b. Malformation or Defect of Penis.—The experiments of Spallanzani and Rossi have shown that in animals complete sexual intercourse is not necessary to impregnation, which was found to follow the injection of semen by a syringe, while the animal was in heat; and John Hunter's ingenious expedient, recommended in a case of fistula in perineo, further proves that in the human subject the semen may be introduced in the same way during the existence of the venereal orgasm with the same result. But the cases to be cited under the head of Pregnancy prove more than this. They show that a female may become pregnant in consequence of intercourse taking place in a state of unconsciousness, even when attended by so little injury to the parts of generation as to attract no attention afterwards; also that pregnancy may occur in women with hymen intact. So that neither the introduction of the male organ nor the venereal orgasm is necessary to impregnation. It follows, then, that small size, or partial mutilation, of the penis is not to be accounted a cause of impotence. Provided that what exists or remains of the organ is large enough to admit of introduction within the orifice of the vagina, and there be no impediment to the emission of semen, fruitful intercourse may take place. Thus, the removal of the glans penis; of the corpora cavernosa (as in a case quoted by Paris, from Piazzoni); of a large portion of the organ (as in

* See Sir Harris Nicolas's Treatise on the Law of Adulterine Bastardy.

† See Casper, vol. iii. p. 258, and p. 291 et seq.

the case quoted by Frank of a soldier struck by a musket-ball), did not occasion impotence. A still more extreme case is on record,* in which, after amputation of the diseased penis, there was only a very small protrusion of the organ on pressure, and yet the mutilated patient became the father of two children. Amputation of the penis close to its root would in all probability cause impotence, though, for the reasons already assigned, impregnation might not be impossible.

The opposite malformation, excessive development, whether normal or a consequence of disease, though it might render complete intercourse impossible, need not prevent impregnation.

Nor would a malformation of the penis, in which the urethra opens elsewhere than at the extremity of the organ, entail impotence. Several cases so malformed but not impotent are on record, comprising instances in which the malformation was hereditary, and one case, reported by Frank, in which it was transmitted through three generations.

When the opening of the urethra, instead of being upon the penis, is in the perineum, sexual intercourse may be rendered fruitful by the artificial introduction of the semen into the vagina, as in Mr. Hunter's case. But as in all such cases, the semen ejected from the remote opening might reach the vagina, either intentionally or by accident, it would be unsafe to pronounce persons subject to such malformation to be incapable of fruitful sexual intercourse.

Hypospadians and *Epispadians* (pp. 39, 40) are incapable of complete sexual intercourse; and to become parents must be assisted by artificial means;† or the discharged semen must in some unexpected manner be conveyed to the sexual organs of the female. The occurrence of cases of hereditary *hypospadia* renders this event probable, while two cases at least of impregnation by hypospadians with the urethral orifice seated at the very root of the penis establish it beyond a doubt. Of these, the case of the hypospadian Johanna K., who became the father of a child similarly malformed, is the most striking.‡ Of *Epispadia*, Casper says that he knows of no example of impregnation by a man so afflicted; while of the two states he says "that of themselves" they form no reason for assuming an incapacity for procreation in the absence of proof that no semen could have entered the vaginal canal.

Congenital phymosis, and a confinement of the penis to the

* Mr. Hurd in 'London Med. and Surg. Journal,' vol. iv.

† 'Ed. Med. and Surg. Journ.' vol. i., pp. 43, 132.

‡ Case by Traxel, cited in Casper's Handbook, vol. iii. p. 250.

scrotum by a peculiar formation of the integuments, are curable causes of impotence. Severe strictures, and disease of the prostate gland, so extensive as to prevent the expulsion of the semen; and palsy of the muscles of the penis, complete the list of the causes of impotence which have their seat in that organ.

c. *Defect or Disease of the Testicles.*—The excision of both testicles early in life occasions impotence; but when they are removed after puberty, complete sexual intercourse may take place for a time, and a person so mutilated may even become a father, by virtue of the semen retained in the vesiculæ seminales. That sexual intercourse may take place for a considerable period after the removal of both testicles is proved by a case related by Sir Astley Cooper.* For about twelve months after the loss of the second testicle there were emissions in coitu; then sexual intercourse took place at distant intervals, but without emission; and, becoming less and less frequent, ceased at the end of ten years. Casper, on the authority of Peter Frank, tells us of four castrated soprano singers, who were banished from a small Italian town for their many sexual misdemeanours. The possibility of fruitful sexual intercourse taking place after castration, rests on the discovery of apparently good semen in the vesiculæ seminales at a considerable interval after the removal of the testicles, as in a case cited by Otto; on the analogy of animals; and on at least one instance in the human subject. Sedillot cites a case on the authority of Boyer, in which after the removal of both testicles a man became a father.†

There has been much unnecessary discussion as to the possibility of a man with only one testicle having children; but as impregnation cannot be supposed to depend on the quantity of the semen, we may safely affirm that one sound testicle is to the full as efficient as two. Men whose testicles are situate in the abdomen or in the inguinal canal are not only capable of sexual intercourse, but (as in the case of a criminal cited by Mahon) may earn a character for extreme licentiousness. The question of their power to impregnate will be considered presently. (*See* Sterility.)

Small size of testicle is not sufficient ground for inferring impotence; for though there are cases on record in which it has coincided with a total absence of sexual desire, there is at least one well-authenticated instance in which, both penis and testicles being originally very small, there were sexual desires, erections

* 'Med. Chir. Rev.' vol. xviii. p. 390.

† Sedillot's 'Manual,' p. 17.

with emissions, gradual increase in size, and fruitful intercourse.* The sufficiency of even a single small testicle is supposed to have been shown in a case which occurred in the reign of Elizabeth. Willimet, the first wife of one John Bury, alleged that he was impotent; and on inspection by two physicians he was found to have but one testicle the size of a small bean, while she was a virgin. On this and other circumstantial evidence, the ecclesiastical court annulled the marriage. But Bury took a second wife, by whom he had a son, and on his legitimacy being called in question, the common lawyers were unanimously of opinion that the ecclesiastical court had been misled, and pronounced the first marriage valid notwithstanding.†

Of the diseases which affect the testicles, and cause impotence, the wasting that sometimes follows attacks of cynanche parotidea is the chief. Foderé witnessed several such cases in deserters condemned to labour on the canal at Arles, and Larrey in many soldiers of the army of Egypt. The testes lose their sensibility, become soft, and shrink to the size of a white French bean, and when both are affected, the beard grows thin, the intellect fails, and impotence results. Larrey could not trace the disease to previous attacks of gonorrhœa, but attributed it to the use of the brandy of dates.

Elephantiasis and malignant diseases, such as scirrhus and medullary sarcoma, may also lead to the same result; but it would not be safe to pronounce in favour of impotence except where the entire structure of both testicles is affected.

Congenital scrotal hernia, long-standing inguinal hernia, and tumours of large size involving the genital organs, or affecting the lower part of the abdomen or upper part of the thighs, may constitute mechanical impediments to sexual intercourse.

d. Constitutional Disease or Debility.—Diseases which occasion extreme debility may become causes of impotence (temporary or permanent), through the weakness to which they give rise. There must always, however, be great difficulty in determining the degree of debility or exhaustion from disease or from age and natural decay which entails impotence.

But the diseases most likely to occasion impotence are those that affect the nervous centres, especially diseases of the spinal cord, whether arising from internal cause, or from mechanical injury. The spinal cord may, however, be the seat of extensive degeneration, giving rise to marked impairment of locomotion, without entailing impotence. But complete paraplegia is usually

* Wilson: 'Lectures on the Urinary and Genital Organs,' p. 424.
† Hargrave's 'State Trials,' vol. x., p. 24.

attended by complete loss of sexual power, though erections sometimes occur either spontaneously or by reflex irritation; again, after partial recovery from paraplegia, the power of fruitful sexual intercourse has been restored.* In the early stage of locomotor ataxy, depending on degeneration of the posterior columns of the cord, there is often, increased sexual desire and power; but this often, though not always, gives way to complete impotence as the disease progresses. In the case of Bagot *v.* Bagot (Irish Probate Court, 1878), the question of the sexual capacity of an ataxic arose; and Dr. Radcliffe testified to the having himself seen cases of ataxia in which sexual capacity and fruitfulness were retained. In hemiplegia from cerebral disease there does not appear to be any direct impairment of sexual capacity, and that fruitful sexual intercourse may take place within a few weeks of a well-marked attack of hemiplegia is proved by the cases adduced on the occasion of the trial of Legge *v.* Edmonds.

Case of Legge v. *Edmonds.*—The following is a careful summary of the facts of this case, which are interesting in a medico-legal point of view. Mr. Legge of Newent, married August 25, 1835, and died June 24, 1844. His wife was delivered of a daughter March 23, 1837, and again of a daughter October 30, 1844, being four months after the death of Mr. Legge. The first child attained the age of two years; the second survived four years. The legitimacy of the second child was called in question, partly on account of the state of health of Mr. Legge at the date of conception, and partly in consequence of the alleged adultery of Mrs. Legge with the defendant, to whom she was subsequently married, and by whom she had children. Mr. Legge was an athletic man, and free liver, occasionally drinking to excess, but not an habitual drunkard. On November 4th, 1843, when about thirty-five or thirty-six years of age, he had a well-marked apoplectic seizure, with loss of speech and hemiplegia of the right side, for which he was actively treated, and was so far recovered by November 27th, little more than three weeks from the date of the attack, as to cease taking medicine. The hired nurse left him at the end of five weeks. After the lapse of a week his speech was partially restored; he left his bed at the end of a fortnight; came downstairs at the end of the third week; and by the end of the fourth week he was walking in the town, and drank tea out. At or about this period he was seen walking about by more than one witness. On December 7th (little more

* See a case quoted from M. Brachet, by Curling on 'Disease of the Testes.' 2nd ed. p. 371.

than a month after the attack), he went to Ledbury in a gig, driving himself part of the way, and signed his name at the bank, taking his hand out of a sling for the purpose. On December 27th he transacted business as usual, and wrote his name. He dined out near Newent before Christmas-day, and rode on horseback before the end of the year. On January 6th he visited Gloucester, and had transactions with several tradesmen. Before the end of the month he supped there, and opened oysters, and on the 31st attended a meeting, at which he took off his coat and challenged one of the company to fight. The most conclusive evidence was brought forward to prove that between the end of November, 1843, and the end of January, 1844, he had repeatedly transacted business, written his name, walked about without support, driven a gig, ridden on horseback, and leaped hurdles, gone out shooting, and killed game. It is also proved by the testimony of several witnesses that he had so far recovered before the end of January as to seem in perfect health. He had no new attack of illness till February 28th. His death in the June following was attributed to a general break up of the system, following dropsy and disease of the liver.

From the foregoing summary, carefully compiled from the notes of Mr. Charles Jones, solicitor for the defence, it appears that there were no medical grounds for assuming incapacity for fruitful sexual intercourse at the end of January, the presumed date of the conception of the daughter whose legitimacy was contested. The adverse opinion of Drs. Taylor and Carpenter was based on other than medical considerations. The inquiry commenced at Cheltenham, was continued in London, when the opinion previously expressed by Dr. Semple, Mr. Walsh, and myself was confirmed by Drs. F. Bird and Blundell, and the following facts were given in evidence:—1. E. K., æt. 58, when thirty-three years of age, had a well-marked attack of hemiplegia of the right side, which has left him lame, and with his speech slightly affected. He alleges that he had connection with his wife within a week of his seizure, that his sexual powers have not been impaired, and that since the attack he has had three children always considered as his own. His wife gives three weeks as the extreme limit of time after the attack at which connection took place. The facts of this case were confirmed by Mr. Wetherfield, of Covent Garden, who added that he had known other cases of hemiplegic patients begetting children. 2. W. D., æt. 32, had an attack of hemiplegia of the right side at the early age of twenty-six, and a second when twenty-eight years old. Intercourse took place within a fortnight of the first attack; and

there have been three children, of whom the first was born about eighteen months from the first seizure. Neither husband nor wife had any doubt that the children were their own. In both these instances the recovery was less complete than that of Mr. Legge.*

Certain drugs, taken in single large doses, or used habitually in excess for long periods, such as opium, spirituous liquors, and tobacco, may give rise to impotence. Other substances of less power, such as camphor, coffee, and nitre, have been mentioned as causes of impotence, but probably with insufficient reason.

Masturbation and early and excessive sexual indulgence are also acknowledged causes of impotence.

2. *Mental causes.*—Excessive passion, timidity, apprehension, superstition, fear, aversion, and disgust have been known to occasion impotence. With the exception of the last-named emotions—aversion and disgust—the rest are transitory, and curable. That impotence with one female is not inconsistent with sexual ability in respect to others is proved by the case of John Bury, already referred to, as well as that of the Earl of Essex, who admitted his inability to know the Countess, but denied his impotence as to other females.†

II. IMPOTENCE IN THE FEMALE.

The causes which prevent sexual intercourse in the female are. 1. *Narrowness of the vagina*, existing in all subjects before puberty, and in rare instances in the full-grown adult. In the latter, the defect may be remedied by emollients and cautious dilatation. 2. *Adhesion of the labia* from inflammation, and obliteration of the vagina from the same cause. 3. *Absence of the vagina*, accompanied in some cases by absence of the uterus. 4. *Imperforate hymen.* This often belongs to the class of curable causes. 5. *Tumours in the vagina*, such as polypi, scirrhous formations, prolapsus uteri, and prolapsus vesicæ. There are other causes which render sexual intercourse so difficult or painful as to deserve mention in connection with this subject. Of these the most important are—unusual shortness of the vagina; inflammatory or malignant diseases of the vagina or uterus; extreme sensibility; a fistulous communication between the vagina and rectum, and internal piles. Of these some are obviously curable, others admit of no relief.

Sterility.—This may occur both in women and in men. In *women* some of the physical causes, such as absence of the uterus,

* The reader will find a full account of this case, differing in some materia points from the preceding, and not comprising the cases of E. K. and W. D., in Taylor's 'Medical Jurisprudence,' sixth edition, p. 675.

† See Hargrave's 'State Trials,' vol. i. p. 315; or abstract by Beck, p. 54.

closure of the neck, or of the Fallopian tubes, may escape detection during life. There are also curable causes of sterility, such as profuse discharges, menorrhagia and leucorrhœa, and alterations in the secretions of the vagina and uterus;* as well as causes little understood, but proved to exist by the fact that women sterile with one husband have become fruitful with another. Promiscuous intercourse, another acknowledged cause, is not a permanent one, as is shown by the fruitfulness of married convicts who have been previously prostitutes.

Sterility in men is more interesting in a physiological than in a medico-legal point of view. It is certainly present in many men who are capable of complete sexual intercourse, and in others in whom there is complete mechanical intercourse without emission. Mr. Curling recognises three causes of male sterility—malposition of the testicles, obstructions in their excretory ducts, and impediments to the escape of the seminal fluid. The second of these causes may be brought about by double "epididymitis" following gonorrhœa, and by scrofulous and malignant degeneration affecting both sides; also by congenital absence of the "vasa deferentia." The third cause may be induced by stricture of the urethra, causing the semen to regurgitate into the bladder; also by other diseases giving rise to like impediments. The first cause is the most interesting, for it appears to entail sterility without causing impotence. Mr. Curling gives a table containing nine cases (four of his own observing), in 2 of which both testicles were in the abdomen, in 2 one or other was there, in 2 both in the groin, the others being mixed cases; and in all these cases there was sterility, and the semen, on examination, was found destitute of spermatozoa. On the other hand, in three cases of non-descent of both testicles, by Mr. Poland, Mr. Cock, and Mr. Durham, the men were married and the reputed fathers of children. Two of them had married twice, and one had children by both wives. Mr. Curling, relying on the ascertained sterility of many of these "cryptorchids," coupled with the absence of spermatozoa, and attaching due importance to analogous observations on animals, is disposed to call in question the claims to paternity in these cases. But as, in order to do so, it would be necessary to suppose the most improbable coincidence of four wives unfaithful with three cryptorchids, the safest course is to adopt the author's own admission :—"I see no valid reason why there should not be exceptions." The rule must be held to be established.† Casper says of this

* M. Donné has shown that these secretions, in females, apparently in good health, are sometimes such as instantly to destroy the spermatozoa.

† Observations on Sterility in Man, with cases. By T. B. Curling, F.R.S.,

class of persons, "Experience proves that cryptorchids are perfectly capable of procreation, and there are, *à priori*, no physiological reasons for doubting this." (Vol. iii. p. 256.)

Directions for conducting examinations in cases of alleged impotence :—

1. Note the age, general appearance, habit of body, and state of health, of the person complained of, and ascertain what diseases he or she may have previously laboured under.

2. Examine the sexual parts with great care; ascertain their degree of development, and explore such openings or canals as may be discovered, by the sound or catheter. Ascertain the condition of the urethra of the male, and the state of the prostate.

3. No gross or indelicate manipulations need be practised, nor artificial stimulus employed.

4. These examinations can only be safely entrusted to skilful and experienced medical men. The examination of females should be conducted by accoucheurs, the jury of matrons being obviously incompetent.

RAPE.

Rape, which was formerly a capital offence, now entails penal servitude for life as its maximum punishment, as does also the carnal knowledge of any girl under 12 years of age. The carnal knowledge of any girl between the ages of 12 and 13 is punishable by two years' imprisonment with hard labour. Indecent assaults on females and attempts on girls under 12 are punishable by imprisonment for two years. (38 and 39 Vict., c. 94, amending 24 and 25 Vict., cap. c., §. 100.)*

Rape being defined as "the *carnal knowledge* of a woman forcibly and against her will," a question has arisen as to the meaning of the term *carnal knowledge*, and whether it implies penetration and emission, or penetration only. Though this difficulty might be supposed to have been set at rest by the 9th of Geo. IV., chap. 31, which distinctly provides that neither in cases of rape,

Surgeon to the London Hospital, &c. 'British and Foreign Medico-Chirurgical Review,' April, 1864.

* According to the law as set forth in the Draft-Code of the Criminal Code Commission, sec. 210:—"Every one shall be guilty of an indictable offence, and shall be liable upon conviction thereof, to penal servitude for life, who carnally knows any girl under the age of twelve, whether he believes her to be of or above that age, or not." By the recommendation of the Commission, sec. 209, attempts to commit rape, which are at present punishable with a maximum of two years' imprisonment with hard labour, are made liable to penal servitude for seven years.

nor in offences *contra naturam,* shall it be necessary to prove the actual emission of seed, but that the carnal knowledge shall be deemed complete upon proof of penetration only, much difference of opinion continued to exist among legal writers, and conflicting decisions were given from the bench, till at length it came to be understood and universally admitted that proof of emission is not required. A question was next raised as to the meaning of the word "penetration," and it was at length decided, after further conflict of legal opinions and decisions, that any introduction of the male organ within the vulva constitutes penetration.*

The least possible introduction, then, of the male organ within the vulva, even short of the rupture of the hymen, and without emission, constitutes a rape, if done forcibly and against the will of the female. Hence the facts to be established are :—1. Forcible penetration, in this limited sense of the term ; and, 2. In the case of females above twelve years of age, that the force was used against the will of the complainant. We have to deal, therefore, with the question of penetration—in other words, the *physical signs* of rape ; and the question of consent. It is in deciding the first question that medical evidence is most obviously required.

PHYSICAL SIGNS OF RAPE.

As the law makes no distinction between married and single, chaste and unchaste, and does not limit the time after the alleged commission of the offence at which an accusation may be preferred, the examination of the female may have to be made under very different circumstances in different cases.

Though, as the meaning attached to the term penetration shows, it is not necessary to prove the existence of any definite amount of injury (as, for instance, the rupture of the hymen where there has been no previous sexual intercourse), the medical man should make a minute and careful examination of the parts of generation, so as to be able to give a clear description of the injury they have sustained. And though the fact of emission need not be proved, the discovery of semen on the person of the female, or on her dress, must obviously be of the utmost importance.

The duty of the medical man when called on to examine the person of a female said to have been violated, will therefore be to examine : 1. the parts of generation, with a view to an exact description of the injury they have sustained ; 2. the body and limbs in order to discover bruises, scratches, or other evidences of resistance to the alleged violence ; 3. the linen worn by the female at

* See Archbold's 'Pleading and Evidence in Criminal Cases.'

the time of the alleged rape, in search of spots of semen or of blood, and, in some cases, of other discharges. It may also be necessary to examine the person and linen of the accused.

1. *The parts of Generation.*—Before considering the injuries these parts may sustain, it will be necessary to inquire into the value of the hymen, and of other alleged signs of virginity; for the crime of rape is most frequently committed on a female who has not previously had sexual intercourse; and it is usual, in the case of adult females, to endeavour to rebut the charge of rape by alleging previous unchastity—a question on which the medical examiner may have to express an opinion.

The Hymen.—Strange as it may seem, the very existence of this membrane has been disputed; and Male, Beck, and Devergie give long lists of those who affirm and of those who deny its existence; but the former have the advantage, both in numbers and authority.

Orfila, in more than 200 subjects he examined, found it uniformly present. Gavard found it in the fœtus, in the new-born infant, in young women from 23 to 25 years of age, and in one of 50. Bennach, of Marseilles, saw it in a woman of 60. Devergie found it invariably present in new-born infants, and met with it in women of different ages exposed at the Morgue, of whom one was 65 and another 72. The same author twice observed the labia minora united through their whole extent, leaving a small aperture above corresponding to the meatus urinarius; and once he found the vagina closed by a false membrane within the labia minora, having a perfect hymen behind it. Devergie concludes, from a careful review of all his authorities, that the hymen is recognizable by marked characters in 99 cases out of 100; and he traces the differences of opinion respecting it to variations in its form and size.*

The hymen is usually found as a semilunar fold, bounding the entrance of the vagina below, and losing itself behind the labia minora in the circumference of the orifice. But it sometimes assumes the form of a circular membrane, with a central aperture adherent by its entire circumference or with a small opening above, corresponding to the meatus urinarius. A most unusual form is that of filaments of mucous membrane uniting the carunculæ myrtiformes.

The hymen, comparatively small at birth, enlarges by degrees, and especially about the period of puberty; when its free edge becomes relaxed and thrown into folds, and these, when ruptured, give rise to those small pyramidal tubercles, from three to six in

* Consult Devergie, 'Des Attentats à la Pudour.'

number, known as the *carunculæ myrtiformes,* which may, therefore, be taken as marks of the previous existence of the hymen.

The recent destruction of the hymen proves the recent use of force; and if there are other marks of violence on the parts and on the person of the female, there can be no reasonable doubt of the commission of a rape, as far as that crime admits of being proved by physical signs.

When the destruction of the hymen is recent, the *carunculæ myrtiformes* are found swollen and inflamed; but they gradually wither and shrink with time.

This absence of the hymen, and substitution of the carunculæ, must not be taken as proof that the female had had previous sexual intercourse, for the membrane may be otherwise destroyed: from within, if the aperture be small, by the first menstrual flux, or by the accumulation of other discharges; from without, by accident, or by foreign bodies purposely introduced; also by disease. It may even be originally wanting, as in a case related by Capuron.

On the other hand, the presence of the hymen cannot be accounted a certain sign of chastity; for it has remained intact after sexual intercourse, and even after the birth of children. Ambrose Paré, Ruisch, Osiander, Nägele, Capuron, Baudelocque, and others give cases of mothers in whom it was ruptured by the child, or divided by the knife; and Tolberg, on the authority of the elder Meckel, cites the case of a woman in whom the hymen was preserved circular and tense after the birth of a fœtus of five months, enveloped in all its membranes. Still a perfect hymen, with the parts of generation and the breasts conforming to the virgin type, affords a strong presumption of chastity.

Besides the intact condition of the hymen, or its recent rupture, other signs of virginity have been enumerated, such as the fresh colour, firmness, and elasticity of the labia, the integrity of the fourchette, the narrow and rugose state of the vagina, a plump elastic condition of the breasts, the difficulty and pain attending intercourse, and the flow of blood. But all these signs are fallacious. This condition of the labia is not always destroyed by repeated intercourse, and in the state of the breasts many widows and mothers may compare with undoubted virgins. The fourchette may remain unruptured after repeated intercourse, and even after child-bearing; and the narrow and constricted vagina is not only not peculiar to virgins, but may be imitated by the use of astringents while the opposite state naturally present during the menstrual period may be induced by profuse menstrual or leucorrhœal discharges. The pain attending a first connection and hæmorrhage are still more fallacious, as both may occur from relative disproportion.

That the fact of previous sexual intercourse is not easy to ascertain, and that the usual signs of virginity may remain after long habits of unchastity, is well illustrated by the following case.*

Two young women of genteel appearance were attacked in the public streets by some young men, who told the passers-by that they were no better than common prostitutes. Certain good-natured persons resented this conduct, and took the girls' part; and a complaint was lodged on their behalf against their defamers, who were summoned before a magistrate. The defendants pleaded a justification, while the females, on the contrary, stoutly insisted on their purity, and even offered to submit to inspection by a medical examiner, which the opposite party dared them to do. A sworn inspector, clever and conscientious, was appointed by the magistrate, and reported that it was totally out of his power to say anything certain as to one of the females; she might or might not be a virgin; but that the other had *probably* had some intercourse with men, though he could not assert the fact positively. Yet it subsequently came out that these young women had actually been for some time on the registers of the police, and had both had repeated attacks of the venereal disease.

The physical signs of rape consist in marks of violence on the organs of generation, proportioned to the force employed, the resistance offered, and the relative disproportion of the parts. In the adult virgin (after complete penetration) the hymen would be ruptured, the fourchette might be torn; and the parts would be covered with blood. In young children, there may be no destruction of the hymen, and no hæmorrhage, but bruising of the external organs. After some hours, there will be marks of recent inflammation, with increased heat and swelling, with profuse discharge at first of mucus tinged with blood, then of a muco-purulent fluid, of a greenish-yellow colour and glutinous character.

Such are the appearances when the injuries are recent: but at the end of three or four days the inflammation will subside, the parts may heal, and no trace of the injury may remain. The injuries inflicted cause a difficulty in walking, and a peculiar gait, which lasts for a day or two in the adult, but longer in children who have been much injured. There is also complaint of pain in micturition, and sometimes in relieving the bowels.

The marks of violence are, *cæteris paribus*, less distinct, and the resulting inflammation less intense, in women who have had sexual intercourse, have borne children, are at the menstrual period, or suffering from any profuse discharge.

These injuries to the parts of generation may exist and yet no rape have been committed; for a first intercourse, with full con-

* Parent-Duchatelet, 'La Prostitution dans la Ville de Paris.'

sent, or a great disproportion of parts in one accustomed to sexual intercourse, would give rise to the same appearances.

Injuries to the organs of generation have also been fraudulently produced, in order to support a charge of rape. Foderé cites a case in which inflamed spots were produced by the pressure of a coin.

Appearances resembling those due to violence may also be occasioned by disease, as was first shown by Dr. Percival in the case of Jane Hampson, æt. 4, admitted an out-patient of the Manchester Infirmary, February 11, 1791. The mother stated that the child first complained of pain in making water the day before, and that on examining the parts, she was surprised to find them highly inflamed, sore, and painful. The child had slept two or three nights in the same bed with a boy fourteen years old, and had complained of being very much hurt by him. Leeches and other external applications, with appropriate internal remedies, were prescribed; but the child grew weaker, and died on the ninth day after her admission. A coroner's inquest was held; prior to which the body was inspected, and the abdominal and thoracic viscera being found free from disease, Mr. Ward, the surgeon in attendance, gave it as his opinion that the death was caused by external violence. A verdict of murder was accordingly returned against the lad. Not many weeks, however, elapsed before several similar cases occurred, in which there was no suspicion of external violence, and some in which it was certain that it had not been offered. A few of these patients died. Mr. Ward was convinced that he had been mistaken, and informed the coroner of his reasons for changing his opinion. Accordingly, when the boy was called to the bar at Lancaster, the jury were told that the evidence adduced was not sufficient to convict; that the trial of the case would give rise to much indelicate discussion. The jury acquitted the prisoner. The case of Jane Hampson had, according to Dr. Percival, been one of a group of cases of a typhus fever, accompanied with a mortification of the pudenda.*

Mr. Kinder Wood has described a similar complaint. Febrile symptoms, lasting for about three days, were followed by dysuria, and enlargement and dusky inflammation of one or both labia, extending to the clitoris, nymphæ, and hymen. Ulceration and progressive destruction of the external organs succeeded. The disease seemed to be a peculiar kind of eruptive fever and proved very fatal.†

Lawrence, in his 'Surgical Lectures,' also described a peculiar

* 'Medical Ethics,' pp. 103 and 231.
† 'Med. Chir. Trans.' vol. viii. p. 84.

inflammation of the external organs of children, as not only serious in itself, but apt to be mistaken for syphilis, so as to give rise to the suspicion of ill-usage: in some instances to legal proceedings.

The disease attacks young subjects of from four to ten years of age; the labia and external organs assume a deep dusky red colour, and become the seat of foul ulcers, with a tawny grey, and sometimes an actual sloughing surface, attended with a thin fœtid discharge, with feverishness, restlessness, great pain, and very considerable disturbance of the health. The ulcers have characters totally different from those of any primary venereal sore. Lawrence had to give evidence in the case of a child suffering from this affection, who, in consequence of professional opinions that it was the venereal disease, was interrogated into the idea suggested and strongly entertained by the parents, that a certain youth had done something or other to her. He was taken to Bow-street, examined, and tried at the Old Bailey.

Wilde describes a like affection of the parts of generation of young children in connection with leucorrhœal ophthalmia, and proves that both affections are contagious.*

We have seen several cases of this deep-coloured inflammation of the genitals with profuse discharge, but without ulceration; and have generally found the friends suspicious of violence (G).

These forms of disease, it should be borne in mind, attack only young children, and are apt to attack several children at the same time, in the same place.

2. The evidence afforded by injury to the parts of generation may derive confirmation from an examination of the person of the female. Violence and resistance must result in bruises and scratches on the groins, thighs and knees, arms and chest; and the clothes may also be torn in the struggle.

3. *The Linen.*—The body clothes worn by the female at the time of the alleged rape may furnish valuable negative evidence, or may issue in the discovery of spots or stains of blood, of menstrual fluid, of semen, or of other discharges.

Blood Spots.—When the injury is recent, the linen will be soaked or spotted with pure red blood; but when the first hæmorrhage has ceased, the blood being mixed with mucus, produces stains less defined, reddish, or yellowish red, lighter in the centre, darker at the circumference. Spots of either kind coinciding with marks of violence, afford a strong presumption of rape.

* 'Medical Times and Gazette,' Jan. 17, 1857. See also Mr. Kesteven in same Journal, April, 1859.

For the chemical tests and microscopic characters of blood spots, the reader is refered to the chapter on Wounds.

The Menstrual Fluid.—It is necessary to be on our guard against confounding blood-stains from ruptured vessels with those due to the menstrual discharge; which is a secretion of the lining membrane of the uterus, of a rich cherry-red colour, not brightened by contact with air, and passing by exposure to a brownish-red. It contains less fibrin than blood, and does not form so firm or thick a clot; though it may be discharged with clots of blood. It has a characteristic sour odour, and an acid reaction, due to the presence of free phosphoric and lactic acids. It also contains mucous globules and epithelial scales from the uterus and vagina. These properties distinguish the unmixed menstrual fluid from blood; but the spots or stains which it forms are not readily distinguished from such stains of blood as are blended with mucus, especially when received on the soiled linen of the class on whom the crime of rape is most frequently committed. Casper, when he states "that there is no distinguishable difference between the two kinds of blood," seems to refer to this difficult class of cases. The fluid might be identified by plugging the vagina. If it came from the upper part of the passage, it might be safely inferred to be menstrual.

If the menses are flowing at the time of an alleged rape, blood will be mixed with the discharge, and found adhering to the injured parts and to the linen, or in copious clots near the scene of the violence. This happened in the case of Mary Ashford:—

The menses were flowing at the time of the alleged rape, and *coagulated* blood was found in the middle of the impression of a figure on the grass. The parts of generation were torn, and covered with coagulated blood; and the shirt and pantaloons of the accused, Abraham Thornton, were also bloody. He confessed the connection, but pleaded consent. The dead body of Mary Ashford was found next morning in a pool of water.*

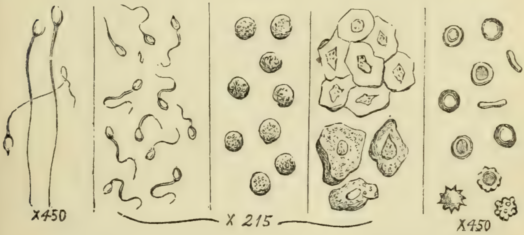
Semen, and Seminal Spots.—When a female is examined soon after a rape, semen may be discovered at or near the orifice of the vagina; or seminal spots may be found on the shift. The real character of the fluid or stain may be determined by the microscope, which reveals the presence of certain characteristic bodies, variously designated as *spermatozoa, zoosperms, seminal animalcules,* and *cercaria seminis.* They exist in the semen of male

* See this case at length in Cummin's Lectures, 'Med. Gaz.,' xxi., p. 386. It occurred in 1817, and excited much interest at the time.

animals that have reached the age of puberty, diffused through the semen in large but variable numbers, mixed with granules or corpuscles of much larger size. They consist of a long slender filament surmounted by an oval or pear-shaped head. They are very minute, their length often not exceeding the 600th of an inch, and the head being about half the size of the human red blood-corpuscle. For several hours after the death of the animal to which they belong, the filament has a peculiar lashing, undulating, or vibrating movement. But when they have ceased to move, they may still be detected by their peculiar shape, which they retain even when dry; and they have been identified after such long intervals of time, as ten months, a year, or even three and four years, in the liquid obtained by steeping seminal stains in a small quantity of distilled water.* They also resist putrefaction, and have been observed in putrid semen kept for ten weeks.†

In the annexed wood-cut (fig. 8) the spermatozoa, and the blood disks, are seen magnified 450 diameters; while the spermatozoa, the mucous bodies, and the epithelium scales, are shown under a lower power, of 215 diameters.‡

Fig. 8.



The shape, size, and motions of the spermatozoa are quite distinctive; nor is their diagnostic value impaired by the discovery made by M. Donné of an animalcule to which he gives the name of Trichomonas vaginæ. It is occasionally encountered in vaginal

* A case of rape, by Dr. Henry Munroe, accompanied by an engraving, showing the spermatozoa, the blood globules, the epithelial scales of the menstrual discharge, and the mucous bodies got by steeping the stains in distilled water. See Beale's 'Archives of Medicine,' vol. i. p. 139.

† Dr. John Dewy, 'Edin. Med. and Surg. Journ." vol. iv. p. 15.

‡ 1 and 5 are from Griffith and Henfrey's 'Micrographic Dictionary,' 2, 3, and 4, after figures in Beale's 'Archives,' vol. i.

mucus, and especially in the discharges of females careless of personal cleanliness. It is mixed with granular bodies of larger size than those of semen, and the head is three times as large as that of the spermatozoa. It has several granules in its interior; and a row of from four to six short cilia spring from its circumference. (Fig. 9.)

Fig. 9.

But seminal spots have other characteristic properties. They are stiff as if starched; of a greyish tint, best seen by placing the linen between the eye and the light; and when moistened give out the well-known seminal odour. If held near the fire—(taking care not to scorch the linen)—the spots change to a yellow fawn colour, and several small whitish spots, not previously perceived, make their appearance. Orfila pronounced this effect of heat to be characteristic, alleging that it does not take place with any other healthy or morbid discharge; not with vaginal mucus or the lochia; nor with gonorrhœal discharge or fluor albus. Pure nitric acid gives to the solution of semen in water a slight tinge of yellow, but causes no precipitate.

The change of colour in the spot when held near the fire, and the peculiar odour of the solution, are highly characteristic. The absence of precipitate with nitric acid is less conclusive.* Casper commends a method of Lassaigne's, by which, on *linen* or *cotton* textures, the seminal spot, with others not caused by albuminous compounds, may be distinguished from secretions which contain albumen, and therefore sulphur. The spot is moistened with a solution of oxide of lead in liquor potassæ, and dried at 68° F. The seminal stain undergoes no change, while the other stains soon assume a dirty yellow or a sulphur yellow hue. (Vol. i. p. 205.)

But though the discovery of zoosperms in a stain is conclusive as to its nature, it must be understood that it may have been caused by an emission and yet contain no zoosperms; for on examining the bodies of men who had died by various forms of violence, it was found that out of 22 young and middle-aged adults (several of them powerful and vigorous men) the organs contained numerous zoosperms in 5, few in 9, and none in 8; while of men above 50, 3 had them in large numbers, and 3 in small, while in three others they were not discoverable. Duplay also found the zoosperms absent in 14 out of 51 old men. A vigorous naturalist, 60 years of age, accustomed to the use of the microscope, examined, with Casper, his own semen after coitus, and they found every variation from no zoosperms at all to zoosperms described as in-

* Orfila; 'Traité de Médecine Legale,' vol. i. pp. 156, et seq.

numerable, and from few or many *small* to few *large*. Casper, therefore, is fully justified in the conclusion at which he arrives, that though stains are proved to be seminal when these zoosperms are found in them, yet that the absence of spermatozoa does not prove that they were not caused by human semen. (Vol. iii. p. 296.)

Of the characters of seminal spots, other than the presence of zoosperms, it should be stated that, though available when we are dealing with clean linen, they are of little value when we have to do with the soiled garments of the poor.

In preparing a spot for examination, care should be taken not to destroy the zoosperms by rough usage. It should be cut out, placed in a watch-glass with a few drops of distilled water, and gently moved about with a glass spatula for a quarter of an hour or so, when the stained tissue will have become softened and permeated with water. It should then be carefully removed, and allowed to drain. From the soaked stain a slightly opalescent fluid may be squeezed with a glass rod on a clean microscopic slide, covered with a disc, and submitted to microscopic examination with a power of not less than 300 diameters. The discovery of zoosperms would be conclusive of the presence of semen; for, as Casper justly remarks, "Whoever has only once seen a single characteristic spermatozoon, dead or alive, can never be deceived again."

Other Discharges.—The physical signs of rape may be complicated by the presence of the venereal disease, and a question arise as to the value to be attached to this fact. As the earliest period after connection at which the disease occurs is about three days, its presence in a female examined soon after the alleged violence would simply prove the female unchaste. If detected at a later period, it would prove the female unchaste if absent in the accused, but form a strong corroboration of the charge if present. In accusations of rape based on the existence of a purulent or muco-purulent discharge in young females, the ascertained absence of gonorrhœa in the accused would be of the utmost importance to the defence. As the gonorrhœal discharge cannot be distinguished with certainty from the purulent or muco-purulent discharges of children, or from the highly coloured leucorrhœal discharges of the adult, great caution is needed in forming an opinion based on the nature of any existing discharge.

The inferences drawn from the state of the parts of generation, person, and linen of the female may be strengthened by the

Examination of the Accused.—If examined soon after the rape, his person may bear distinct marks of resistance; and the linen worn at the time may be found soiled with blood and semen. He

may also have used such force as to cause a rupture of the frænum. On the other hand, the accused may prove to be too weak, or of too tender, or too advanced, an age to be justly chargeable with rape; or it may happen that he is impotent, in which case the charge must fall to the ground.

Allegations of rape are sometimes confirmed by an inspection of the spot on which the offence was alleged to have been committed. It may bear distinct traces of a struggle, and be found covered with blood, as in the case of Mary Ashford, cited above.

When death follows rape, the parts of generation, and the body itself, will have to be carefully examined, and the nature and extent of all injuries ascertained. The mouth should be inspected in search of foreign bodies that may have been introduced to stop the victim's cries.

Though the inspection of the persons of the complainant and of the accused may leave no doubt that forcible sexual intercourse has taken place, the proof of rape may still be incomplete; for the female may have consented after offering a certain resistance. The sufficiency of the resistance, and the question of consent* generally, are reserved for the jury, guided by the following considerations:—The previous character of the female, and her relations with the accused; the motives that may have actuated her in bringing the accusation; the place and circumstances in which the crime was alleged to have been committed; the time that elapsed before complaint was made; whether, if other persons were near at hand, her cries were heard; and whether if discovered, she made resistance and cried out before the discovery. The question of consent has of course no place in the case of children under twelve years of age, of idiots, or of females in a state of unconsciousness, however produced.

This question of consent has been summarily answered by alleging the impossibility of committing the crime on a woman of ordinary strength in full possession of her senses. That this, though very difficult is possible, is sufficiently proved by Case LIV., p. 311, vol. iii., of Casper's Handbook; but as the term rape is now understood, the offence must be admitted to be possible where there is great disparity of strength. The female, too, may faint from fright, or yield to threats of worse violence.

Two other questions still remain to be discussed. 1. Can a female be violated during sleep without her knowledge? and, 2. Does pregnancy ever follow rape?

* According to the statement of the law by the Criminal Code Commission, nothing shall be deemed consent which is either extracted by threats or fear of bodily harm, or obtained by personating her husband, or by falsely and fraudulently misrepresenting the nature and quality of the act. Sec. 207.

1. *Can a female be violated during sleep without her knowledge?*—That a rape may be committed during the *stupor* produced by narcotics, there is no doubt; that a female, accustomed to sexual intercourse may be violated during profound sleep, is also highly probable;* but that a virgin should be subjected to forcible and complete sexual intercourse, is in the highest degree improbable. Under the head of pregnancy, cases will be cited to prove the possibility of intercourse with a sleeping woman being followed by pregnancy, which has taken the female by surprise—a proof that the connection was not accomplished by violence.

2. *May Pregnancy follow Rape?*—Pregnancy may follow unconscious connection; hence the venereal orgasm is not a *sine quâ non*: it may also follow a first intercourse with consent. It is, therefore, in the highest degree improbable that an event which may follow an act unconsciously performed, and in spite of the pain of a first intercourse, should be prevented even by the most passionate repugnance.

It now only remains to give some short directions for medico-legal examinations in cases of alleged rape.

1. Visit the female without giving time for preparation, and note the time of the visit, and that at which the offence is stated to have been committed. Avoid leading questions, especially in the case of children.

2. Ascertain complainant's age, strength, and state of health, examine the injuries of which she complains, and see whether they correspond with the assigned cause.

3. Examine the organs of generation, and note whether they are bloody, swollen, abraded, inflamed, or ulcerated; whether there is any discharge, and whence it flows: whether the hymen and fourchette are injured, and if so whether recently, and whether the carunculæ myrtiformes are present; ascertain the date and origin of marks of violence, and determine whether they might not have been produced by other than the alleged cause, as, for instance, by foreign bodies, purposely applied to, or introduced into, the parts. Inquire, also, whether the alleged violation took place during the menstrual period, or while the female was suffering from any relaxing discharge.

4. If there is any discharge, observe its quantity, and collect a portion of it for examination: and proceed in the same way with spots of blood or semen found on the person or clothes.

* In the year 1840, I was consulted by a poor woman, who, after mentioning other complaints of little importance, stated that she was somewhat alarmed by the fact of her sleep being so heavy that she was with difficulty roused. She added, by way of illustration, that her husband had assured her that he had frequently had connection with her during sleep (G.).

5. If death have taken place, a complete examination must be made of the body and the internal viscera; search being made for bruises, fractures, or dislocations, and for foreign bodies thrust into the mouth.

6. Examine the spot on which the offence was committed.

Lastly. Examine the person of the accused; and the parts of generation with a view to discover whether he be impotent, or capable of producing the existing amount of injury, whether he have the venereal disease, or any recent abrasion or rupture of the frænum. Examine his person also, with a view to discover bruises, scratches, or other marks of resistance; and his linen for spots of blood or semen. Note also, whether he is strong or weak, healthy or the reverse.

If the joint examination of the complainant and accused do not support the charge of rape, it may justify the charge of assault with intent to commit it; and another indictment may be preferred, charging the prisoner with the misdemeanour.

PREGNANCY.

Medical examinations for legal purposes may be required both in cases where pregnancy is truly alleged to exist, and where it is feigned or concealed.

Pregnancy may be *feigned* by the unmarried to extort money, to touch the feelings of a paramour or seducer, or to influence a jury in the assessment of damages for breach of promise; by the married to gratify the wishes of a husband, or to produce a supposititious heir to an estate; and also, both by single and married, to stay the execution of capital punishment. Pregnancy may also be *concealed* both by married and unmarried, to avoid disgrace, to procure abortion, or to commit infanticide.

The most common occasions for examination arise at common law, when a widow, on the death of her husband, by alleging that she is with child, disappoints the heirs to the estate; and in criminal courts, when a woman condemned to death pleads pregnancy in stay of execution.

The legal procedure in the first case is by the issue of a writ *de ventre inspiciendo*, the examination being entrusted to a *jury of matrons*, or discreet women, generally twelve in number, who, if they find the female pregnant, are charged with the duty of narrowly watching her till her delivery. In the second case, the duty of the jury is to ascertain, not only whether she is pregnant, but also whether she is *quick with child*.

This jury has not always been constituted in the same manner;

and it is now a common practice to require the aid of skilled medical examiners. Thus in the case of Mrs. Fox,* two medical men and two matrons were appointed to visit her once a fortnight: and in a criminal case (Mary Weeks, indicted for the murder of George Weeks, Western Circuit, March 20th, 1856), the counsel for the defence having moved for a stay of execution, as the prisoner was quick with child, the doors of the court were ordered to be locked, and a jury of matrons was called into the box, sworn and charged to inquire into the fact. Two medical men were also sworn to examine the prisoner, and give evidence before the jury, who retired for a short time, and, on returning, found that the prisoner was in the condition alleged. Sentence was accordingly respited till the prisoner should be delivered. A similar practice was followed in the case of Christiana Edmunds, convicted of poisoning at Brighton in 1871, who falsely pleaded pregnancy as a bar to execution; and again on a like plea, also proved false, by Kate Webster, convicted of the murder of Mrs. Thomas at Richmond in 1879. The jury of matrons is an absurd anachronism in the present state of medical science, and ought to be expunged from legal procedure.†

A court of law has also admitted a prisoner to bail on proof of her pregnancy. A case for medical examination may also arise under the act 1 Gul. IV., chap. 22, which provides that a deposition may be read in evidence when it can be shown to the satisfaction of the judge that a witness is unable, from permanent sickness or other infirmity, to attend the trial. It has been ruled that imminent delivery is a cause for examination under this act.

As the subject of pregnancy is one that involves many details, it will be examined under the following distinct heads:—1. *The signs and symptoms of pregnancy during life.* 2. *Examination of the uterus and its appendages after death, with a view to the discovery of proofs of an existing or previous pregnancy;* and 3. *Questions of a medico-legal nature connected with pregnancy.*

* 'London Med. Gaz., vol. xvi. p. 697; vol. xvii. p. 191.

† In the Draft Code of the Criminal Code Bill Commission (1879), this is recognised by Section 531. "If sentence of death is passed upon any woman, she may move in arrest of execution on the ground that she is pregnant. If such a motion is made, the court shall direct one or more registered medical practitioners to be sworn, to examine the woman in some private place, either together or successively, and to inquire whether she is with child of a quick child or not. If upon the report of any of them, it appears to the court that she is so with child, execution shall be arrested till she is delivered of a child, or until it is no longer possible in the course of Nature that she should be so delivered. After the commencement of this Act no jury de ventre inspiciendo, shall be empanelled or sworn."

I. SIGNS OF PREGNANCY.

The leading Signs of Pregnancy are here briefly described, the reader being referred for more accurate information to works on midwifery, or to monographs treating expressly on the subject.*

Constitutional Signs or Symptoms.—An irritable and capricious temper, sadness and languor; a worn and dejected expression of countenance, nausea, heartburn, loathing of food, a capricious, variable, or depraved appetite; vomiting, especially in the morning, and a costive state of bowels; feverishness, determination of blood to the head, with eruptions on the face; and in some cases salivation, and pains of the face and teeth; are recognised symptoms of this state. Taken separately, they have little value, and even when several coexist, are not conclusive.

The Breasts.—The changes in the breasts consist (*a*) in increased size and firmness; (*b*) in a moist dark circle, or areola, studded with mucous follicles formed round the nipple; and (*c*) in a mixed secretion of milk and serum flowing from the nipple.

The Uterus.—The signs referable to this organ are *a.* suppression of the menses; *b.* changes in the size and shape of the abdomen; *c.* quickening; *d.* changes in the neck and orifice of the uterus; *e.* increased size; *f.* ballottement; *g.* discoloration of the mucous membrane of the vagina; *h.* sounds heard on applying the stethoscope to the abdomen.

a. Suppression of the Catamenia.—The menses may be suppressed for long periods, from causes other than pregnancy; or they may be present for one or two periods after conception, and even during the whole course of gestation; or, again, they may be absent at other times, and appear only after conception. Moreover, the sign is wanting in females who become pregnant without having menstruated. A woman who is really pregnant may also conceal the fact by pretending that she is regular, and imitating the catamenia by blood.

b. Changes in the Size and Shape of the Abdomen.—These consist in a symmetrical enlargement, first perceptible about the end of the third month, and increasing up to the time of delivery. Before the third month the uterus sinking into the pelvis causes the abdomen to appear flattened, and the umbilicus depressed.

c. Quickening.—This is vulgarly attributed to the movements of the child, which was then supposed to acquire independent vitality, a idea embodied in the legal phrase of being "quick with child," but the real cause is not quite determined. It is

* Consult Montgomery, 'Cyclo. of Pract. Med.,' art. Pregnancy, and his 'Signs of Pregnancy.' Also Dr. Tanner's work on the same subject.

attributed to a sudden change in the position of the uterus. The sensation of quickening gives place to the ordinary movements of the fœtus which continue during the rest of the period of utero-gestation. Quickening usually takes place between the 14th and 18th week, but sometimes as early as the 12th. It is a very fallacious sign; for these movements may not be perceived at all, or they may be confounded with the motions of flatus, changes in the position of the viscera, or sudden contractions of the muscles.

d. Changes in the Neck and Orifice of the Uterus.—The neck of the impregnated womb is full, round, soft, and elastic; the margins, or lips, lose their well-defined edge, and become soft, swollen, and indistinct; and in advanced pregnancy, the neck becomes shorter, and is at length no longer to be felt. The orifice, instead of being transverse, becomes circular, and admits the point of the finger more readily, and to a greater depth. The womb also shifts its position as pregnancy advances; it rises higher, the fundus is tilted forward, and the neck backward.

e. Increased Size of the Uterus.—During the first three months, the womb not having yet risen out of the pelvis, no enlargement is discoverable even by examination per vaginam; but at the end of the fourth month it may sometimes be felt above the pubes; and during the fifth, both externally and per vaginam. As this gradual increase of size may obviously be due to causes other than pregnancy, it is not a sure sign of it.

f. Ballottement.—This is the name given to the sensation caused by the fall of the fœtus after it has been jerked upwards by a brisk movement of the finger. It is not available till after the fourth month, and rarely much beyond the end of the sixth. In practised hands it is a sign of great value.

g. Discoloration of the Mucous Membrane of the Vagina.—The mucous membrane of the vagina of the pregnant woman has a tint like that of lees of wine. This, though an excellent sign of pregnancy, is inconvenient in application.

h. The Stethoscope.—Two sounds may be heard on applying the stethoscope over the region of the gravid uterus; *the pulsations of the fœtal heart*, and *the uterine murmur.* The *pulsations* of the fœtal heart vary from 120 to 160 in a minute, and bear no relation to the pulsation of the mother. Each pulse is double, and resembles the tick of a watch heard through a pillow. It is not always heard in the same place, but generally on one side, at a point nearly midway between the navel and the anterior superior spine of the ilium; it is occasionally inaudible. When heard, it is a sure sign of pregnancy. It fails in the case of a dead fœtus, and is inapplicable at an early period of gestation. The *uterine*

murmur is a low cooing sound, such as is made by blowing gently over the lip of a wide-mouthed phial. It is synchronous with the pulse of the mother, and may generally be detected in the lateral or anterior parts of the uterus, being first distinctly audible about the end of the fourth mouth.

The Urine.—A glistening scum (consisting of triple phosphate and minute fungoid and confervoid growths) is found floating on the urine of pregnant women, after standing one or two days; and under the name of *Kyestein* was once deemed a certain sign of pregnancy. Though generally present in pregnancy, it has been shown to occur also in anæmic women who are not pregnant. This, then, like the fact that the urine in pregnancy often contains grape sugar, is of little value as a sign.

Of the foregoing signs few are conclusive when taken by themselves; while many are extremely fallacious, and are liable to be simulated by various diseased conditions, or to be obscured by co-existing diseases of the uterus or of the abdominal viscera. The best of these signs can only be duly appreciated by experienced persons, to whom alone this class of inquiries should be entrusted.

Substances expelled from the womb sometimes furnish evidence of pregnancy. The chief of these are, 1. An early ovum. 2. Moles. 3. Hydatids. 4. False membranes.

1. *An Early Ovum.*—This may be recognised by the characters of the contained fœtus, and by the appearance of its membranes. The fœtus during the early stages of its development will be described in the next chapter. The membranes are highly characteristic. The decidua is known by its soft, rich, pulpy appearance and strongred colour, its rough external surface perforated by small foramina, and its smooth internal surface. The inner decidua has a smooth outer surface, while its internal one is covered with the filaments that receive the arborescent villi from the surface of the chorion. These appearances are not assumed by any product of disease.

2. *Moles.*—Some authors regard these bodies as products of conception. If so, they will be identified as such by the discovery of some constitutent parts of an ovum; but if no such parts are found, it is right to assume that the substance under examination was not due to impregnation.

3. *Hydatids.*—There is a decided balance of opinion in favour of these being in all cases products of conception. But as hydatids may spring from portions of membrane that have been retained for several months, they cannot serve to fix the date of the pregnancy.

4. *False Membranes.*—These are often expelled in dysmenorrhœa; and a careless observer might pronounce them products of

conception. The rule already laid down, that no substance expelled from the womb should be deemed a product of conception, unless it contain constituent parts of an ovum, must be observed also in this case. For an illustration of a false membrane discharged during painful menstruation, see fig. 17, p. 94.

II. POST-MORTEM EXAMINATION.

This may be necessary, in order to determine the existence, or previous occurrence, of pregnancy.

The womb itself, by presenting the characters of the virgin state, may at once negative the supposition of pregnancy. Or it may be found enlarged, but empty, and marked by some of the changes that accompany gestation; which appearances, however, may be due to any tumour which had distended the organ, and formed a vascular connection with it. If the womb is not empty, its contents must be carefully examined, and if traces of an ovum be discovered, the fact of previous impregnation would be made out.

Much importance formerly attached to certain appearances in the *ovaries*, as signs of pregnancy; and on the trial of Mr. Angus, of Liverpool, for the murder of Miss Burns, a *corpus luteum* found in the ovary was held to prove the fact of recent pregnancy, in the face of much difference of opinion as to the conclusions to be drawn from the state of the womb itself.

The value of the *corpus luteum* as a sign of previous impregnation has been a subject of lively discussion, and the characters which distinguish the true corpus luteum, the product of conception, from the false, as found in virgins, have been very minutely described. It results from this discussion, that the distinction is not so marked as to justify us in making a confident use of it for medico-legal purposes.* But between the corpora lutea of the adult virgin ovary, and those of the pregnant woman, the differences are such as ought to be pointed out and illustrated. If conception does not occur, the corpus luteum rarely attains a size greater than a small pea, and in general becomes reduced to an insignificant cicatrix by the end of six or eight weeks. On the other hand, if impregnation occurs, the corpus luteum instead of retrograding continues to increase, and reaches its maximum development between the third and sixth month of gestation. It continues until

* Casper states, as the result of his many post-mortem examinations, "that the corpora lutea found after pregnancy are not to be distinguished with any certainty from the corpora lutea, the result of the detachment of unfecundated ovula" (vol. iii. p. 360), and Kirkes (Physiology, 1st edit. p. 606) characterized as *unsafe* "all evidence of previous impregnation founded on the existence of a corpus luteum in the ovary."

parturition, after which it begins to dwindle, but its characteristic structure may still be apparent for some months after delivery. The appearances of the corpora lutea of menstruation and impregnation are well illustrated by the following figures taken from the able monograph of Dr. Arthur Farre.* Fig. 10 shows the longitudinal section of an adult virgin ovary, with Graafian follicles of ordinary size before enlargement, and stellate remains of follicles which have burst and shrunk after discharging their ova. In Fig. 11, 1, shows the section of an enlarged follicle, with central blood clot, from a woman who died on the tenth day after the commencement of her last menstruation; 2, the section of a large follicle which had recently burst and discharged its contents; while 3 and 4, show a superficial and a deeper section taken from the ovary of a woman who died at the end of the fourth month of gestation; and 5, the stellate follicle two days after mature delivery. The appearances shown in the last three figures may be deemed characteristic. They have "discharged an ovum, which has been afterwards impregnated." The question of prior pregnancy based on the appearance of the ovaries should alway be submitted to some competent authority known to have carefully studied the subject.

Fig. 10.

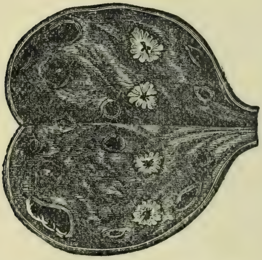
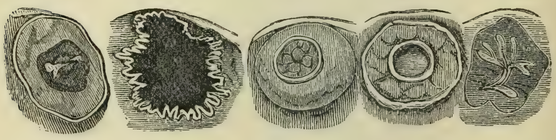


Fig. 11.

1 2 3 4 5



III. MEDICO-LEGAL QUESTIONS.

These questions are—1. The limits of child-bearing ? 2. Can a woman conceive while in a state of unconsciousness ? 3. Can a

* The Uterus and its Appendages, from the Cyclopædia of 'Anatomy and Physiology.' By Arthur Farre, M.D. Cantab., F.R.S.

woman remain ignorant of her pregnancy up to the time of delivery? 4. Does the presence of the hymen rebut the supposition of pregnancy? And 5. Is superfœtation possible?

1. *The Limits of Child-bearing.*—According to Casper child-bearing may begin as early as the 13th year, and end as late as the 52nd. (Vol. iii. p. 259.) But cases of pregnancy have occurred both at younger and more advanced ages. Sir E. Home has recorded an instance of pregnancy in the 13th year and another in the 12th. La Motte gives a case of delivery before 13; and we have it on the authority of Paris and Fonblanque that "in the year 1816 some girls were admitted into the *Maternité* at Paris as young as 13 years; Mr. Roberton the case of a factory girl little more than 12 years old delivered of a still-born child; and Mr. Smith of Coventry one at 12 years 7 months; Bruce, in Abyssinia, and Dunlop, in Bengal, met with mothers of 11 years. In a case of criminal assault on a girl under 12, tried before Mr. Day, Q.C., sitting as Commissioner ("Reg. *v.* Dean"), it was proved in evidence that a girl had been delivered of a full-grown child, which is still living at the age of 12 years and one month. The prisoner, who was the girl's stepfather, was convicted of the felony and sentenced to 10 years' penal servitude. (*Times,* Jan. 16, 1879.) Blumenbach gives an instance of pregnancy in a Swiss girl in her 9th year (Male p. 176); Joubert and Schurigius cases at the same early age (Smith, p. 496). During the French Revolution one or two instances occurred of females at 11, and even below that age, being received in a pregnant state into the *Maternité.**

On the other hand, cases are recorded of pregnancy at very advanced ages. Roberton records a case in the 53rd year; Bartholomew Mosse, Knebel, and Roberton each one in the 54th year; a case of pregnancy at the same age (that of Mrs. Ashley) is also related in the 'Edinburgh Annual Register' for 1816. In a French case, in which the succession to an estate was disputed on the ground of the mother being 58 when the child was born, a decision was given in favour of the fact. Pliny, Valescus de Tarenta, and Marra of Venice, record cases of pregnancy at 60. The Countess de Taxis is stated to have borne a healthy child at the age of 62 (Smith, p. 496). Capuron states that a woman of 63 was generally believed in Paris to have given birth to a daughter; and lastly, Beck quotes a case from the 'Boston Medical and Surgical Journal,' of a woman at Whitehall (State of New York) becoming a mother at 64.

* See a paper by Dr. J. G. Wilson, 'Edin. Med. Journal,' October, 1861.

It will be observed that there are four cases at 54, after which the earliest occurred at 58, and the latest at 64; both these being solitary instances.

As the first and last menstruation are usually supposed to fix the limits of possible fruitfulness, and as early and late cases do certainly lend support to cases of early and late pregnancy, it may be well to state that menstruation at nine years is not uncommon in England or on the Continent. Male met with two instances of regular return and partial development of the breasts at six. In one French case, menstruation is recorded at five years. The occurrence of the discharge, even in the first year of life, rests on good authority. Dr. Drummond reports the case of a child which, according to the mother's account, had begun to menstruate at the age of *two weeks*, the discharge lasting from two to three days, and occurring as nearly as possible, every month. At the age of four years the breasts and genital organs, with the exception of the absence of pubic hair, were quite those of puberty.*

Out of 1500 cases to which I directed my inquiries, I found one of menstruation before the completion of the eighth year. On the other hand, I have known menstruation to continue uninterruptedly as late as the 57th year (G.); and Dr. James Reid recorded instances for every year from that age up to the 69th, inclusive. Cases of menstruation recurring, after interruption, at a still more advanced age are also on record.

As the age at which the menses first appear admits of medico-legal application, it may be well to state that the 14th and 15th years are the most common epoch of their commencement, then the 16th, then the 17th and 13th, then the 18th and 12th, and the other ages in the following order:—the 11th, 19th, 20th, 10th, 21st, 22nd, 9th, and 23rd (G.).

The most common period for the disappearance of the menses would seem to be from the 45th to the 50th year, inclusive; but the instances before 40 and after 50 are numerous.

2. *Can a Woman Conceive while in a state of Unconsciousness?*—The answer to this question is affirmative. Capuron says, "It is a fact, which experience has more than once confirmed, that a woman may become with child while in a state of hysteria under the influence of narcotics, during asphyxia, drunkenness, or deep sleep, and consequently without being conscious of it, or sharing the enjoyment of the man who dishonours her." This statement is fully borne out by a case given by Capuron himself,

* 'Brit. Med. Journal,' vol. ii. 1879, p. 47.

in which the unconscious intercourse took place during a profound sleep produced by punch; by a case cited by Beck, Art. Pregnancy, in which the same result was brought about by wine; and by a third case communicated to Foderé by Desgranges, in which opium was administered with the same intent.

As examples of conception following intercourse during profound sleep, two cases may be cited, the one on the authority of Dr. Gooch, the other on that of Dr. Cusack. Of unconscious intercourse followed by pregnancy during a prolonged fainting fit, an instance was communicated to me by Mr. Hewitt of Berkshire (G.); and of violation with the same result during asphyxia, or apparent death, an instance is cited by Foderé (vol. i. p. 500) from the 'Causes Célèbres.'

There are, therefore, various conditions of insensibility, during which connection may take place and be followed by conception.

3. *Can a Woman remain ignorant of her Pregnancy up to the time of Delivery?*—In the case just referred to this is quite possible. A woman who is not conscious of having exposed herself to the risk of becoming a mother, would naturally attribute her enlargement, and all the attendant symptoms, to any cause but the true one. A like ignorance is perhaps possible when, as in a case quoted by Foderé, on the authority of Desgranges, a young girl yields to the solicitations of her lover, and has connection with him under the assurance that, under the peculiar circumstances, she runs no risk. In this instance the connection took place in a bath, and the girl assured Desgranges that that circumstance had removed all idea of pregnancy.* The popular belief that a single coitus, and such incomplete connection as leaves the hymen uninjured, cannot be followed by impregnation, may give rise to real ignorance of the existence of pregnancy. Foderé also refers to cases in proof of the confidence placed by pregnant women in the precautions they had taken.

In all such cases it is possible, though unlikely, that a female may attribute her symptoms to disease, and really believe what she so much desires should be true, the wish in this, as in other things, being father to the thought; and as the married woman, anxious for offspring, construes every unusual sensation into a sign of pregnancy, and makes serious preparations for the event which is to crown her wishes, so the single woman, whose wishes all tend the other way, may sincerely attribute to any cause but the

* Foderé. vol. i. pp. 496-7. Beck quotes this case as illustrating the position that ignorance of pregnancy may exist "when the female is an idiot." But though Desgranges describes the girl as "assez-niaise," there seems no good reason to regard her as an idiot.

true one, every symptom of a state which threatens her with exposure. But even married women who have no motive to misunderstand or misrepresent their true condition, may, up to the very last, attribute it to a wrong cause. The conditions under which this is most likely to happen are such as occurred in a case reported by Dr. Tanner. A lady 42 years old, and married three years, after menstruating scantily for five or six months previously, had ceased to be unwell for about nine months, was taken in labour, and delivered by instruments of a mature female infant. Both parents, though anxious for children, despaired of having them, and the lady had no suspicion that she was pregnant, and received with unaffected incredulity the statement that she was not only in that state, but had been in labour for ten hours.*

But perhaps the most remarkable instance on record of pregnancy ignored, if not by the female herself, at least by those most likely to suspect her, was furnished by the Hawkins divorce case tried before the House of Lords, May, 1852. The husband, after an absence of ten months from England, rejoins his adulterous wife, cohabits with her more than two months, and even sleeps with her up to within five minutes of her delivery— a circumstance the more extraordinary as he had already cohabited with her during two previous pregnancies. Nor was the true state of the case suspected by any of her friends and acquaintances, by her maid who had dressed and undressed her up to the night of her confinement, or by her medical men, the alteration that had taken place in her personal appearance having been uniformly attributed to illness; and it was by medical advice that she remained in England while her husband served abroad. Singular as were the facts of the case, the Lord Chancellor expressed his belief that the petitioner was wholly unconscious of his wife's state till she gave birth to the child.

4. *Does the Presence of the Hymen rebut the supposition of Pregnancy ?*—This question is answered by the facts quoted at p. 62, proving that the hymen may survive repeated intercourse, and not be destroyed even by delivery.

5. *Is Superfœtation possible ?*—This question is discussed under the head of Legitimacy, to which it properly belongs.

DELIVERY.

Delivery, like pregnancy, may be concealed or pretended;—concealed, with a view of hiding shame, or destroying the child; pretended, in order to produce a suppositious heir to an estate,

* A Case of Unsuspected Pregnancy and Labour. By Thomas Hawkes Tanner, M.D., 'Trans. of the Obstetrical Society of London,' vol. iv. 1863.

to bring about a marriage, or to satisfy the wishes or appease the anger of a husband.

Hence the medical man may be required for medico-legal purposes to ascertain the existence of delivery in concealed cases, and its non-existence in pretended cases. The latter class is rare, but the former of frequent occurrence, especially in accusations of infanticide, when the suspected mother has to be examined to determine whether she has been recently delivered. A similar inquiry may be called for in the dead. A question may also be raised whether a female has borne children at a former period, and (especially in trials for infanticide) as to the possibility of a woman being delivered while unconscious, or in such a position and in such circumstances as, without any criminal act of hers, to endanger the life of her child.

This subject, therefore, resolves itself into four divisions:—1. *The signs of recent Delivery in the Living.* 2. *The signs of recent Delivery in the Dead.* 3. *The signs of a previous Delivery in the Living.* 4. *The signs of a previous Delivery in the Dead.* 5. *Other Medico-Legal Questions connected with Delivery.*

I. SIGNS OF RECENT DELIVERY IN THE LIVING.

When an examination is made within a few days after delivery, the following appearances are present:—The *face* is pale, as in one recovering from a slight illness; the eye sunken, and surrounded by a dark circle. The pulse is quickened, and the skin, soft and warm, is moistened with sweat of a peculiar and unpleasant odour. The *breasts,* especially on the third or fourth day, are found full, tense, and knotty. The nipples are turgid, and the areola presents the appearances proper to the state of Pregnancy. The breasts when pressed or drawn yield a milky fluid which presents microscopic characters of some practical value in connection with delivery as well as with infanticide. For the first five or six days after delivery, the fluid that may be expressed from the breasts is more watery and opalescent than ordinary milk, and less white and opaque. Under the microscope, the ordinary milk globules are seen mixed with epithelium, and the compound granules known as *colostrum corpuscles.* The figures annexed compare the *colostrum* from a healthy woman 12 hours after delivery (fig. 12.), with the milk of another healthy woman after the lapse of a week* (fig. 13). The *abdomen* is distended, its integuments are relaxed and thrown into folds, and its lower part, from the pubes to the navel, marked by light-coloured broken streaks or cracks. On pressing the hand firmly over the pubic

* After 'Day's Physiological Chemistry,' Plate 5.

region, the imperfectly contracted uterus is felt about the size of the head of a new-born infant, rising three or four inches above the brim of the pelvis, and inclining more to one side than the

Fig. 12.

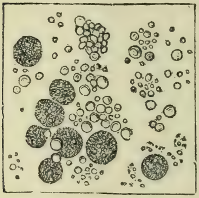
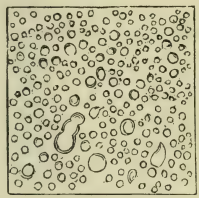


Fig. 13



other. The *external parts of generation* bear distinct marks of distension and injury. They are swollen and relaxed, and not uncommonly bruised and torn. After a first labour, the fourchette is often ruptured, and the injury sometimes extends deep into the perineum. On examination *per vaginam* the *uterus* is found enlarged, and corresponding with the external tumour, the os uteri gaping, so as to admit two or three fingers, and its margins relaxed, flabby, and fissured. Within a few hours of delivery, the orifice is so open that its margin cannot be distinguished, and it seems a continuation of the vagina, which is dilated, relaxed, and smooth, from the disappearance of the rugæ. During the delivery much pure blood escapes from the torn vessels of the womb, and for the first two or three days, but sometimes much longer, a bloody discharge (the *lochia*) flows from the genitals. This, when no longer mixed with the blood first discharged, is found to be destitute of fibrin, though rich in blood-corpuscles, epithelium scales of various forms, pus-cells, and fat globules. For about the same length of time, the discharge becomes nearly colourless, or acquires a light brown or dirty greenish hue, whence the vulgar name "green waters," and has a peculiar sour odour, resembling that of fish-oil—an odour very difficult to conceal or destroy; and this again is succeeded by a milky mucous discharge, which continues for four or five weeks.

The value of these signs depends upon their being found in combination: for the uterus and vagina may be enlarged and the external parts distended by any tumour recently expelled; a discharge may flow from the genitals, and the breasts may enlarge and secrete milk, from sympathy with the distended uterus; the abdomen, also, may display all the marks of recent distension.

The examination should be made without delay; for the signs may disappear before the tenth day; and as a general rule after that date the results are not satisfactory. It may even be difficult to give a decided opinion at an earlier period, especially if the fœtus be small and the mother vigorous.

Of early abortion, again, the appearances are slight and evanescent, quite unreliable before the end of the second month.

II. SIGNS OF RECENT DELIVERY IN THE DEAD.

The external parts have the same appearance as in the living. The uterus presents different appearances, according as death has happened soon after delivery or later. In the former case the os uteri is found wide open, and the womb itself flat and flabby, measuring 9 to 12 inches, containing large clots of blood clinging to the soft and pulpy remains of the decidua; its inner surface, and the attachment of the placenta distinguished by its dark colour, the small number of flocculi, and the semilunar openings on its surface.

The womb in course of time becomes more and more contracted. In the first two or three days after the delivery of a mature child, it is about seven inches long by four broad; its external surface vascular, and marked by purple patches from an inch to an inch and a half thick; the section of the colour and consistence of firm muscular fibre. Its internal surface retains the appearances just described. At the end of a week it is between five and six inches long and about an inch thick; less vascular, but more firm; the inner surface still bloody, and partially covered by decidua. At the end of a fortnight the length does not exceed five inches, and at the end of a month it has resumed its original size. But the os uteri never closes so completely as in the virgin state. The Fallopian tubes and one or both of the ovaries are found turgid and vascular, and the ovaries present one or more corpora utea.

III. SIGNS OF A PREVIOUS DELIVERY IN THE LIVING.

The external marks consist of silvery lines, or "shining broken streaks, like the remains of cracks," on the skin of the breasts and abdomen, and especially in the groin. These marks are often absent, and, when present, merely indicate great previous distension followed by sudden subsidence. The marks on the abdomen are, for obvious reasons, the most fallacious; but those on the breasts are very unlikely to be caused by any other form

of distension. When the two coexist they furnish strong evidence either of a former delivery, or of some distension of the womb producing sympathetic enlargement of the breasts. An experienced hand will detect in the os uteri a peculiar, jagged condition, on which much stress has been laid. The marks of a previous rupture of the fourchette or perineum would also afford confirmatory evidence. On the other hand, we may find an imperforate vagina or a narrowness quite inconsistent with either pregnancy or delivery, or a perfect hymen may afford a presumption against a previous delivery. (See p. 62.) The following case shows how difficult it may be to prove the fact of a previous delivery :—"We very lately examined a patient who had borne five children, and nursed three of them, the youngest being now five years old; the breasts were small, but neither flaccid nor pendulous; the nipples short, with not the least shade of brown colour in the areolæ, which exhibited only the delicate rose colour so often observed on that part of the virgin breast; there were neither lines nor spots of any kind on the abdomen; the os uteri was small and natural; the vagina contracted, and the fourchette perfectly entire. It should be mentioned that this lady never carried her children beyond the end of the eighth month." *

IV. SIGNS OF PREVIOUS DELIVERY IN THE DEAD.

In the dead body, provided decomposition is not too far advanced, we have the same indications of a previous delivery as in the living. The uterus, however, resists decomposition longer than any of the other soft parts or viscera, and it may be of importance, as in the Wainwright case, to determine from the uterus alone whether the woman has borne children or not.

It would appear from the discussion which this case gave rise to in the Obstetrical Society of London (Feb. 1876), that the differences between the virgin and maternal uterus are not so marked as to be implicitly relied upon in the absence of other evidence, or of such a nature as to be clearly distinguishable from the effects of disease causing distension of the uterine cavity.

The following, however, are the chief characters usually stated as belonging to the virgin and maternal uterus respectively, and it is to be noted that the differences are more particularly evident in cases of multiparæ.

The *virgin* uterus, or uterus which has not borne children, is almost triangular in shape, the base line between the Fallopian tubes being nearly straight. The *os externum* is transverse or

* Montgomery, 'Cyclo. Pract. Med.' vol. iv. p. 504.

round, with smooth lips, and the *os internum* is distinct. Between the two the rugæ of the arbor vitæ are well marked.

The shape of the cavity is distinctly triangular with the sides incurved. As regards the measurements and weight, the estimates given by different observers vary so much that they cannot be taken as constant. Barnes* gives the weight at puberty as from 360–1000 grains; the length of the cavity 2·10 in. divided in the following manner: cavity of the body, 0·9 in.; cavity of the neck, 1·00 in.; the intermediate cavity or canal of the isthmus, 0·20 in. The average thickness of the uterine walls is from 0·40 in. to 0·60 in.

The *maternal* uterus is less distinctly triangular, and the base line between the Fallopian tubes is convex. The os externum is enlarged, irregular, and fissured, and the os internum not so well defined. The rugæ of the arbor vitæ are generally smoothed out. The cavity is less distinctly triangular. Its shape is altered so that the length of the cavity of the body exceeds that of the neck, reversing the relations seen in the virgin uterus.

The measurements, weight, and thickness of the walls of the uterus are all increased. According to Barnes the weight is from 1,200 to 1,800 grains; the length of the cavity, 2·30 in., divided into—cavity of the body, 1·10 in.; neck, 1·00 in.; and isthmus, 0·20 in.

In old age the uterus undergoes atrophy and may be reduced to 100–200 grains.

V. OTHER MEDICO-LEGAL QUESTIONS CONNECTED WITH DELIVERY.

Two such questions still remain to be examined. 1. Can a woman be delivered in a state of unconsciousness? 2. Can a woman, if alone and without assistance, prevent her child from perishing? The first of these questions will be examined in this place; the second belongs to the subject of Infanticide.

Can a woman be delivered in a state of unconsciousness? This question can be answered in the affirmative. The event may happen under the influence of narcotics or ardent spirits; and during coma, delirium, or puerperal convulsions, attacks of apoplexy, deep sleep, and suspended animation. Cases of unconscious delivery are not likely to happen in a female pregnant for the first time; but in women who have borne many children, and have easy deliveries, such an event is more probable.

* 'Diseases of Women,' 2nd ed. 1878, chap. i.

CHAPTER III.

FŒTICIDE. INFANTICIDE. LEGITIMACY.

THESE subjects cannot be understood without a preliminary knowledge of the growth and development of the Embryo and Fœtus.

GROWTH AND DEVELOPMENT OF THE FŒTUS.

It used to be asserted that a distinct ovum containing a defined embryo cannot be discovered in the womb before the 20th or 22nd day; but Velpeau* saw three ova not more than twelve days old, and Sir E. Home found a very minute ovum in the womb only eight days after impregnation.† The following account of the development of the embryo is based chiefly on the description of Devergie,‡ with the estimates of length and weight given by Hamilton, Burns, Capuron, Chaussier, Maygrier, Foderé, Orfila, Devergie, and Velpeau and Bichard's measurements of the fœtal skeleton; the French figures being reduced to English standards.

Embryo, Three to Four Weeks.—Length, about $\frac{1}{3}$ inch. *Weight,* about 20 grains. *Size,* that of a large ant, or a barley-corn. *Form,* that of a serpent, the head indicated by a swelling, the caudal extremity slender, and ending in the umbilical cord; the mouth indicated by a cleft; the eyes by two black points; the members appearing as nipple-like protuberances. The villosities of the chorion uniformly spread over the surface.

Six Weeks.—Length, from half an inch to less than an inch. *Weight,* from 40 to 75 grains. The head distinct from the chest, and the face from the cranium, and the apertures of the nose, mouth, eyes, and ears perceptible; the hands and forearms in the middle of the length, and the fingers distinct; the legs and feet situate near the anus; a distinct umbilicus for the attachment of the cord, which consists of the omphalo-mesenteric vessels, of

* 'Embryology,' p. 50. † Gooch's 'Midwifery,' p. 88.
‡ 'Médecine Légale,' art. Infanticide.

part of the urachus, of the intestinal tube, and of filaments which represent the umbilical vessels. The placenta forming; the chorion and amnion still separate; the umbilical vessel very large. *Points of ossification* in the clavicle and maxillary bone.

Two Months.—Length, variously stated at from $1\frac{1}{2}$ inch to 4 inches. *Weight,* 2 to 5 drachms. Rudiments of nose, lips, and eyelids; organs of generation visible; arms and legs distinct from trunk; anus marked by a dark spot; rudiments of lungs, spleen, and supra-renal capsules; cæcum behind the umbilicus; digestive canal withdrawn into the abdomen; urachus visible; chorion touching the amnion at the point opposite the insertion of the placenta, which begins to assume its regular form; umbilical vessels becoming twisted. *Points of ossification* in frontal bone and ribs.

Three Months.—Length, variously stated at from 2 to 6 inches. *Weight,* from 1 ounce to 3 ounces. The head voluminous; the eyelids and lips in contact; membrana pupillaris visible; fingers separated; lower extremities longer than rudimentary tail; parts of generation prominent, and the sex distinguishable by the lens; thymus and supra-renal capsules present; the ventricles of the heart distinct. The decidua uterina and reflexa in contact; the funis containing umbilical vessels and a little gelatinous matter; placenta completely isolated; the umbilical vesicle, allantois, and omphalo-mesenteric vessels have disappeared.

Four Months.—Length, variously stated at from $4\frac{1}{2}$ to $8\frac{1}{2}$ inches. *Weight,* $2\frac{1}{2}$ or 3, to 7 or 8 ounces. Skin rosy, and tolerably dense; mouth very large and open; membrana pupillaris very evident; nails appearing; sex distinct; gall-bladder forming; meconium in duodenum; cæcal valve visible; umbilicus near the pubes. Complete contact of chorion and amnion; membrane forming at point of attachment of placenta to uterus. *Points of ossification* in lower parts of sacrum; ossicula auditoria ossified.

Five Months.—Length, variously stated at from 6 to $10\frac{1}{2}$ inches (a still-born male 13, female $13\frac{1}{2}$; male born alive 9, female 10, inches). *Weight,* 5 or 7 ounces to 1 pound 1 ounce. (A still-born male, 1 pound 13 ounces [Schmitt]; two still-born twin females, 1 pound 6 ounces, and 11 ounces [G.]). Head still comparatively large and covered with a light down; nails very distinct; skin without sebaceous covering; heart and kidneys very bulky; gall-bladder distinct; meconium of a yellowish-green tint at commencement of large intestines. *Points of ossification* in pubes and os calcis; germs of the permanent teeth.

Six Months.—Length, variously stated at from 8 to $13\frac{1}{2}$

inches. *Weight,* 1 lb. to 2 lbs. 2 oz. Skin, with some appearance of fibrous structure, is covered with down and sebaceous matter; the body of the colour of cinnabar; eyelids still adherent; membrana pupillaris still existing; funis inserted a little above pubes; meconium in upper part of large intestines; liver dark-red; gall-bladder contains insipid serous fluid; testes near kidneys. *Points of ossification* in the four divisions of the sternum. Centre of body at lower end of sternum.

Seven Months.—Length, variously stated at from 11 to 16 inches. *Weight,* 2 lbs. to 4 lbs. 5 oz. Skin dusky red, thick and fibrous, and covered with sebaceous matter; hair about $\frac{1}{4}$ inch long; nails not reaching ends of fingers; eyelids no longer adhering; membrana pupillaris disappearing; meconium occupying nearly all the large intestine; left lobe of liver almost as large as right; gall-bladder containing bile; brain firmer; testicles more distant from kidneys. *Point of ossification* in the astragalus. Centre of body a little below the sternum.

Eight Months.—Length, 14 to 18 inches. *Weight,* 3 lbs. 4 oz. to 5 lbs. 7 oz. Skin rosy, covered with fine short hairs, and with well-marked sebaceous envelope; nails reaching ends of fingers; membrana pupillaris has disappeared; testicles descend into the internal ring. *A point of ossification* in the last vertebra of the sacrum. The middle point of the body nearer the umbilicus than the sternum.

Nine Months or Full Term.—Length, 16 to 20 inches. *Weight,* 4 lbs. 5 oz. to 7 lbs. The head covered with hair about an inch long; skin coated with sebaceous matter; the down absent, except about the shoulders; testes have passed inguinal ring, and are often found in scrotum; meconium at termination of large intestine. *Points of ossification* in centre of cartilage at lower end of femur; os hyoides not ossified; four portions of occipital bone distinct; external auditory meatus cartilaginous.*

* Casper attaches the utmost importance to the state of the ossification in the lower epiphyses of the femur, as determining the degree of maturity of the fœtus; and as the test is applicable when only a skeleton is found, it may stand us in stead when all other signs are wanting.

Though no other long bone exhibits the slightest appearance of ossification in the last, or tenth lunar month, of gestation, in the second half of that month an ossific point appears in the lower epiphysis of the femur. This is shown by cutting into the knee-joint, and then taking successive slices of the cartilage till the greatest diameter is reached. A coloured point thus becomes visible in the milk-white cartilage, in the form of a more or less circular light blood-red disc, much harder than the surrounding tissue. In decomposed bodies, however, the cartilage is of a pale dirty-yellow tint, and the ossific point a dusky red. Casper states, as the result of 464 examinations, that if this point is not seen, the fœtus cannot be older than 36-37 weeks. When this point is not seen in mature infants (and this happens in one case out of

In former editions of this work (pp. 77 and 78 of the fourth edition) two tables were inserted, founded on the accurate observations of different authors, and presenting not only the average weights and measures, but the two extremes, and distinguishing the still-born from those born alive. As it is not often that these tables would have to be referred to for practical purposes, they are omitted from the present edition.

The weight of the fœtus at full term has been the subject of many investigations, and as it is important in itself and interesting as throwing light on the probable limits of variation at earlier periods of gestation, the results, as deduced from upwards of 20,000 observations, by Quetelet, Camus, Lécieux, and Baudelocque, and by Drs. Macaulay and Clark, including the facts in the table, are subjoined:—

Greatest 14 lbs.; least 2 lbs. 6 oz.; average, 6 lbs. 11 oz.

But much greater weights have been recorded. Dr. Merriman gives one exceeding 14 lbs.; Sir Richard Croft one, and Dewees two, of 15 lbs.; Dr. Ramsbotham, senior, and Dr. Moore, of New York, instances of 16½ lbs.; and Mr. Owens, of Ludlow, one of 17 lbs. 12 oz., and even this is said to have been exceeded.

The following is the length of the fœtus at full term, as given by different English and French authors:—

Greatest, 26 inches; least, 17 inches; average, 19 inches.

But in certain cases the length has exceeded even this maximum. Dewees, for instance, met with a length of 27 inches.

It may be well to add that, as a rule, still-born infants are heavier and longer than those born alive, males than females, single children than twins, and twins than triplets.

The marks of maturity and immaturity will be stated more fully under the head of Legitimacy.

FŒTICIDE, OR CRIMINAL ABORTION.

The crime of abortion consists in unlawfully administering to any woman, or causing to be taken by her (whether she be with child or not), with intent to procure her miscarriage, any poison

34) its absence coincides with defective organization, and otherwise retarded development. When the ossific point is the size of a hemp seed (half a line), it indicates an age of 37-38 weeks. In the rare cases in which it has this small size at full term, there is defective development elsewhere. A diameter of from ¾ to 4 lines, indicates maturity: and we can conclude, almost certainly, that the infant has survived its birth if the ossific point exceeds four lines, or a third of an inch in diameter. Casper has seen no exception to this rule; but, on the other hand, a less diameter than three lines, or a quarter of an inch, is consistent with an infant having survived its birth.

or other noxious thing (see Toxicology, chapter i.), or using for the same purpose any instrument or other means whatsoever; also in the use of the same means with the same intent by any woman being with child (24 & 25 Vict. cap. c. § 58, 59). It is also an indictable offence and punishable by five years' penal servitude to supply any "poison or other noxious thing, or any instrument, or anything whatsoever" for the purpose of procuring abortion. The statute is silent as to the distinction between women *quick* and *not quick* with child.

The first duty of the medical examiner is to inspect any substances that may have been expelled from the womb. If he finds them to be products of conception, he may have to determine whether their expulsion was due to natural causes, to drugs, or to violence. Sometimes, too, he may have to determine whether the female in whom the abortion is alleged to have taken place, has been recently delivered. Three different examinations therefore may be required.

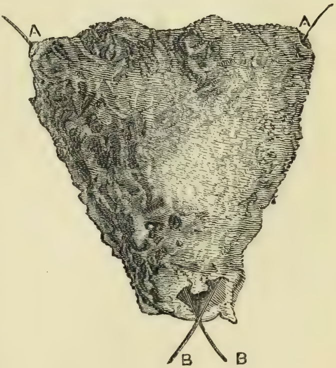
1. An examination of substances expelled from the womb.
2. An inquiry into the cause of the abortion; and
3. An examination of the female supposed to have miscarried.

1. *Substances expelled from the Womb.*—It is only in the early periods of gestation that this examination offers any difficulty. When the embryo has attained a certain degree of development, its appearance is quite characteristic. The rule already laid down (p. 76), in speaking of moles and false membranes as signs of pregnancy, must be observed in cases of alleged abortion, viz. to admit no substance to be a product of conception in which distinct traces of an ovum cannot be recognised. To this rule hydatids form a solitary exception.

The annexed figures from Hunter's 'Gravid Uterus,' show the appearance of early ova, in contrast with that of a false membrane discharged in dysmenorrhœa. Fig. 14 exhibits a complete ovum of about three weeks, with bristles A B, A B, traversing the cavity, from the angles A, A, corresponding to the Fallopian tubes to the point opposite the neck of the uterus. Fig. 15 shows the same ovum with much of its anterior wall cut away. A small hydatid which complicated the figures unnecessarily has been omitted. The two figures are reduced to about two-thirds of the original. Fig. 16 shows an ovum of about eight weeks, consisting of the chorion and its contents, without the decidua. The size of the figure is the same as in the original. Fig. 17 represents a portion of the lining membrane of the uterus cast off during painful menstruation. It presents all the characters of a true decidual

structure, having on the side which corresponded with the uterine cavity a fine cribriform surface, and on the reverse side the rough flocculent appearance characteristic of the outer surface of membranes ordinarily discharged along with the ovum in abortion.

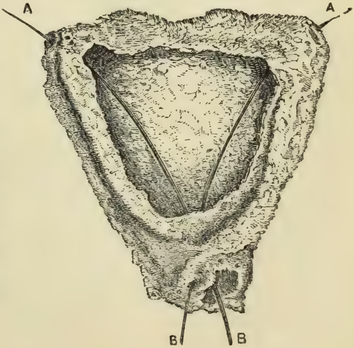
Fig. 14.



Having ascertained that the substance submitted to our inspection is really a product of conception, we must next determine its age by comparing it with the description already given of the growth and development of the embryo and fœtus, p. 88 et seq.

2. *Cause of the Abortion.* — In considering the cause of an abortion attributed to drugs or force, it is necessary to be armed with some preliminary knowledge respecting the occurrence of abortion from natural causes. This is known to be very common, especially in the early months, and it has been variously stated as occurring in 1 out of 12, or even (Dr. Granville) 1 in 3 of the total number of conceptions. Accoucheurs who have had to deal chiefly with women in more advanced periods of pregnancy have estimated the proportion much lower (*e.g.*, 1 in 188, Madame La Chapelle). The causes of these miscarriages will be conveniently considered under the title of

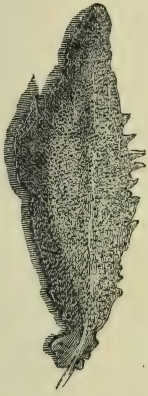
Fig. 15.



Natural Causes.—These are either (*a*) *predisposing*, or (*b*) *exciting*. *a*. The *predisposing* causes may affect either the

Fig. 16.

Fig. 17.



female herself or the ovum. The females most liable to abortion are the plethoric, the irritable, the nervous, the lymphatic, the feeble, and the ailing: also those suffering from excessive or irregular menstruation and leucorrhœa; from syphilis, scurvy, asthma, and dropsy, and from malignant diseases. Malformations of the pelvis, its small size in those who marry very early, tight lacing, and all diseases of the womb or its appendages which restrain the complete development of the organ, also act as predisposing causes. To these may be added, rigidity of the womb in those pregnant for the first time at a mature age, and a relaxed condition of the neck. Occasionally, abortion has been epidemic.*

The predisposing causes dependent on the state of the ovum are very numerous, especially in the early months. According to Velpeau, of upwards of 200 embryos expelled before the end of the third month, at least one half were diseased. The disease may be in the membranes, in the placenta, or in the fœtus itself;

* See references to such epidemics in Velpeau's 'Art des Accouchemens,' art. Avortement.

and it may assume any form of structural degeneration. Disease of the fœtus, or its annexes, affords, of course, a strong probability in favour of abortion from natural causes.

A woman who has once miscarried is likely to miscarry again from the same cause, and at or about the same period of gestation; and it is usual to attach some importance to the mere force of habit. In a case given by Heberden ('Commentaries,' p. 15), there were no less than 35 miscarriages.

b. To the *occasional*, or *exciting* causes, belong strong and sudden actions of the muscles of the abdomen, as in coughing; straining efforts to void urine or fæces, &c.; violent exercise, as in dancing; profuse discharges from the bowels or from the womb itself; undue excitement of the genital organs; blows, and various forms of mechanical injury.

All these occasional or exciting causes fail to produce abortion when the ovum is sound and the female healthy; but the most careful abstinence from all exciting causes will not prevent abortion when the predisposition from either cause is strong.

The *criminal means* are best divided into two classes, *general* and *local;* the first acting through the constitution of the mother, the second by immediate application to the abdomen or uterus.

1. *General, or Constitutional. Venesection.*—The popular belief in bleeding as an abortive rests on the authority of Hippocrates. But it is a notorious fact that pregnant women bear blood-letting well, that it is often the best means of averting a threatened abortion, while the assumption that it promotes abortion is rebutted by numerous well-attested facts. Cases are recorded of women bled 48, 80, and 87 times in the course of their pregnancies, without miscarriage; and Dr. Rush, who resorted to bleeding very freely in the yellow fever of 1793, asserts that not one pregnant woman to whom he prescribed it died or miscarried.

The popular belief in the efficacy of bleeding from the foot rests on no better foundation, nor does the removal of blood by *leeches* to the *anus* or *vulva*—a practice rarely resorted to in this country—possess any peculiar efficacy.

Emetics.—During the early months of pregnancy, and even in some cases throughout its entire duration, severe and distressing vomiting occurs, without producing abortion; and several active irritant poisons productive of violent vomiting have failed to cause miscarriage. These facts afford a presumption against the efficacy of emetics, except in women strongly predisposed.

Cathartics.—These remedies, too, may be given repeatedly,

and in very large doses, without producing abortion, except, as before, in women strongly predisposed. Dr. Rush's experience in the yellow fever of 1793 is conclusive on this point.*

Diuretics.—These remedies, too, have been classed among abortives, but without sufficient reason. Irritant poisons, which act in moderate doses as diuretics (*e.g.*, nitre), may occasion abortion; but not simply by their diuretic action.

One irritant poison specially deserves notice in this place: namely, *cantharides*. It is a strong emetic, purgative, and diuretic, acting violently on the organs in the immediate neighbourhood of the womb, viz., the bladder and rectum, occasioning also intense fever and great weakness; and yet even this drug in full doses may fail (as in a case related by Mr. Lucas, of Leeds). The frequent failure of such active poisons throws great doubt on the efficacy of less powerful remedies in the absence of a decided predisposition to miscarry.

Emmenagogues.—Under this name a vast number of active and inert remedies are classed, most of which have as little effect on the womb as on other parts of the body. *Savin*, *mercury*, *snakeroot*, and *pennyroyal*, have been classed under this head.

The last-named drugs do not appear to be very efficacious. Mercury and its preparations, even when given in large doses, and causing profuse salivation, appear to be attended with little risk. But *savin* has some pretensions to be considered dangerous: for, in common with other irritant poisons, it has undoubtedly occasioned abortion in more than one instance, though it has failed in others, and in others, again, has killed both mother and child.

Closely allied to the so-called *emmenagogues* is the *secale cornutum*, or ergot of rye, which possesses the remarkable property of exciting the muscular fibres of the uterus to contract, and is in frequent use for that purpose. Concerning the efficacy of this remedy, much difference of opinion exists. Some authors have supposed that the power of the ergot is limited to the period of delivery, and to the state of full expansion and development of the uterus. But this opinion is refuted by cases in which it produced abortion at an earlier period of gestation, and experiments on animals have shown that it may be effectual at any period. On the other hand, several cases are recorded by Drs. Condie and Beck of the failure of repeated large doses of ergot.

The root of a plant called the *Actæa racemosa* has the reputation of being nearly as active as the ergot.

Digitalis has been classed among abortives on the strength of

* 'Med. Observations and Inquiries,' vol. iii. p 249.

a case related by Dr. Campbell. The drug was given for dropsy; the child was still-born, and the mother died soon after. Dr. W. H. Dickinson ('Med. Chir. Trans.,' vol. xxxiv. p. 1) has shown that digitalis in such doses as from ʒss to ℥iss of the infusion, and ♏xx to ♏xl of the tincture, has a specific action on the womb; and its power of producing abortion, though not proved, is to be inferred from the facts stated.

It results from these observations on the power of drugs, that there is no medicine that can be depended on to procure abortion in women not strongly predisposed; that if given in doses short of those which risk the life of the mother, they would almost certainly fail; that when they do succeed, they place her life in jeopardy, and often sacrifice it; and that, for every case in which the mother escapes, there is probably one at least in which mother and offspring both perish, and one in which the mother dies, the child remaining intact in the womb.

Local, or *Mechanical Means.*—These consist either of *external violence,* or of *instruments introduced into the womb.*

External violence is a sufficient cause of abortion. But it would appear that unless it is such as to endanger the life of the mother, it is not effective.

In 1811 a man was executed at Stafford for the murder of his wife. She was pregnant, and he succeeded in inducing abortion by violently elbowing her in bed, rolling over her, &c.; but he also caused her death.* A female in the last month of her pregnancy was struck on the abdomen by her husband. An extensive detachment of the placenta caused the immediate death of the fœtus, and that of the mother fifty-one hours after.†

Severe injuries not directly inflicted on the abdomen often fail to occasion abortion. Thus, Madame La Chapelle tells us of a young midwife, who was pregnant and had a narrow pelvis; and to procure abortion and avoid the Cæsarian section, threw herself from a height. She died from her wounds, but did not miscarry. Mauriceau also gives the case of a pregnant female seven months gone, who to escape from a fire slid down from the third story, but, losing her hold, fell on the stones and fractured her forearm, but there was no abortion.

The same remarks apply to the *introduction of instruments into the womb* by unskilful persons. In some instances abortion has been procured; in others, after considerable injury had been inflicted on the vagina and uterus, the child was born alive; and in all of them the mother's life has been endangered or sacrificed.

Sulphuric acid has been injected into the vagina with a view of

* Smith's 'Forensic Medicine,' p. 305. † Campbell, op. cit. p. 131.

producing abortion; and occasioned violent inflammation of the parts, and adhesion of the os tincæ, with the formation of a dense membrane over it. After attempting delivery by incisions into the neck of the womb, it was found necessary to perform the Cæsarian operation—and both mother and child died.*

A case which occurred in the practice of Dr. Wagner, of Berlin, illustrates so forcibly the difficulty of procuring abortion in women not predisposed, whether by medicines or by force, that it will form a fitting conclusion to this subject.

A young woman, seven months with child, had employed savin and other drugs to produce miscarriage. As these failed, her paramour bound a strong leathern strap (the thong of a skate) tightly round her body. This too availing nothing, he (by his own confession) knelt upon her with all his weight, and trampled on her while she lay on her back. "As this also failed, he took a sharp-pointed pair of scissors, and proceeded to perforate the uterus through the vagina. Much pain and hæmorrhage ensued, but did not last long. The woman's health did not suffer in the least; and pretty much about the regular time, a living child was brought into the world without any marks of external injury upon it."†

Examination of the female.—We should be guided in this by the signs already laid down at p. 83; bearing in mind that they are less strongly developed in the early months, and that before two months little dependence can be placed on them.

If the female dies, we may be required to examine the body, and must be guided by the signs of delivery as at the full period, but less distinct as the period of utero-gestation is earlier.

The following is a summary of the chief points to be attended to in cases of *abortion*:—

1. The supposed product of conception must be submitted to minute and careful examination. If a fœtus has been expelled, its age must be determined by the rules already laid down.

2. The reputed mother, whether alive or dead, must then be examined;—if alive, we must ascertain, if possible, whether there was such a predisposition to abortion as to account for it without attributing great efficacy to the means employed. To determine whether or not such a predisposition exists, we must inquire into the general state of health of the mother before the

* Report of M. Guerin to the Académie Nationale of Paris, cited in the 'Lancet,' vol. viii. p. 38.

† The methods employed by skilled abortion-mongers are the same as those used by legitimate practitioners with a view to induce premature labour. It is only when fatal accidents occur, or evidence oozes out in some way, that these criminals are brought to justice.

abortions—and if so whether they occurred at or about the same period of gestation. If the female died from the means employed, we must use the same care in examining the uterus, and must observe the rules hereafter to be laid down for conducting post-mortem examinations.

Some questions of medical ethics mix themselves up with the question of abortion, as

Under what circumstances, and by what means, is it morally and legally proper to induce premature delivery? and what circumstances will justify the Cæsarian operation?

Such questions are easily answered. The medical man is clearly justified in resorting to any measure which promises to preserve the life of mother and child when both are threatened; and where one only can be preserved, the female herself may use her right of self-preservation, and choose whether her own life or that of her child shall fall a sacrifice to the means recommended.

INFANTICIDE.

No criminals meet with so much sympathy as women guilty of Infanticide. This feeling, largely shared by members both of the medical and legal profession, is partly explained by the exceptional nature of the crime, and partly perhaps by the extreme harshness and cruelty of a former statute (21 Jac. I., cap. 27), which virtually visited the concealment of shame with the punishment of murder.* It was under the influence of that injustice that Dr. William Hunter, in 1783, wrote his celebrated essay 'On the Uncertainty of the Signs of Murder in the case of Bastard Children.' Twenty years later (1803) an Act was passed decreeing that women accused of infanticide should be tried by the same rules of evidence as obtain in other trials for murder; but that if acquitted, they may be tried for concealment of the birth, and, if found guilty, punished by imprisonment for a term not exceeding two years.

The provisions of this statute were confirmed by an Act passed June, 1828 (9 Geo. IV. cap. 31), which also provides that it shall not be necessary to prove whether the child died before, at, or after its birth. The Consolidation Act (24 and 25 Vic. cap. 100) adopts and extends these provisions.†

Questions of infanticide are necessarily more complicated than

* Such legal severity is generally found to defeat itself: hence real cases of child-murder are usually treated as cases of mere concealment of birth.

† § 60. *Concealing the birth of a child*, is to the following effect:—If any woman shall be delivered of a child, every person who shall by any secret disposition of the dead body of the said child, whether such child died before, at

abortion took place, and especially whether she has had previous those of homicide in general; for, before inquiring how a child has come by its death, it is necessary to show that it was born alive. The suspected mother may also have to be examined, in order to determine whether or not she has been recently delivered.

Two classes of questions, then, may be raised in cases of infanticide: the one relating to the child; the other to the mother.

Those relating to the child are the following:—

1. What is the degree of maturity of the child?
2. Was the child born alive?
3. If born alive, how long did it survive its birth?
4. How long has the child been dead?
5. What was the cause of death?

I. MATURITY OF THE CHILD.

This will be determined by a careful comparison of the length and weight of the child, the position of the centre of the body,

or after its birth, endeavour to conceal the birth thereof, shall be guilty of a misdemeanour, and being convicted thereof shall be liable at the discretion of the Court, to be imprisoned for any term not exceeding two years, with or without hard labour: provided that if any person tried for the murder of any child shall be acquitted thereof, it shall be lawful for the jury by whose verdict such person shall be acquitted, to find, in case it shall so appear in evidence, that the child had recently been born, and that such person did, by some secret disposition of the dead body of such child, endeavour to conceal the birth thereof, and thereupon the Court may pass such sentence as if such person had been convicted upon an indictment for the concealment of the birth."

The following two Sections (§ 185, § 186) of the Draft Code of the Criminal Code Commission have been proposed to secure punishment for child-murder, where there would be practical difficulty in obtaining a conviction for that offence.

§ 185. *Neglecting to obtain assistance in child-birth.* — "Every woman shall be guilty of an indictable offence, and shall be liable upon conviction thereof to penal servitude for life, who, being with child, and being about to be delivered, with intent that the child shall not live, neglects to provide reasonable assistance in her delivery, if the child dies either just before, or during, or shortly after birth, unless she proves that such death was not caused either by such neglect or by any wrongful act to which she was a party."

§ 186. *Neglecting to obtain assistance in child-birth in order to conceal birth.*—"Every woman shall be guilty of an indictable offence, and shall be liable upon conviction thereof to seven years' penal servitude, who, being with child, and being about to be delivered thereof, with intent to conceal the fact of her having a child, neglects to provide reasonable assistance in her delivery, if the child is permanently injured thereby, or if the child dies either just before, or during, or shortly after birth, unless she proves that such death was not caused either by such neglect or by any wrongful act to which she was a party.

"No woman shall be entitled to be acquitted of any offence against this or the last preceding section, because the facts proved amount to murder or manslaughter; but no woman who has been convicted or acquitted of an offence under this or the last preceding Section, shall be afterwards tried for the murder or manslaughter of such child, or for any other offence on the same facts."

the proportional development of its parts, the growth of the hair and nails, the state of the skin, the presence or absence of the membrana pupillaris: and, in the male, the descent or non-descent of the testicles, &c. (See *ante*, p. 88.)

II. WAS THE CHILD BORN ALIVE?

The legal meaning of *born alive.*—To constitute live birth, the child must be living after the whole body has been brought into the world; and it must have an independent circulation; but this does not imply the severance of the umbilical cord.

In examining the body of a child with a view to determine whether it was born alive, the chief point to be attended to is the state of the lungs: for if these organs show signs of respiration, there is a probability in favour of live-birth; if not, there is an equally strong probability that the child was still-born. But as, in the absence of signs of respiration, proof may still be forthcoming that a child was or was not born alive, the present inquiry will consist of two parts: 1. The evidence of live-birth, prior to, and independent of, respiration. 2. The evidence of live-birth subsequent to, and deduced from, respiration.

The evidence of live-birth prior to respiration is negative or positive,—negative when the body bears marks of previous death within the womb; and positive when there are injuries on the body of the child which must have been inflicted while the blood was still circulating, and so extensive and severe that they could not have been accidental, or have taken place *during* the birth.

Intra-uterine maceration.—A child that has died and undergone maceration in the womb, presents these appearances:—All parts of the body are soft and flaccid, the chest and abdomen flattened, the ribs distinctly visible through the skin, the ilia prominent, the head so soft and yielding that it falls flat in whatever position it may be placed. The periosteum readily separates from the bones; and the cuticle is easily detached in patches from the true skin, and on the hands and feet is white, thick, and wrinkled, as if from a poultice. The true skin is more or less extensively discoloured, the change beginning on the abdomen, which is mottled and of a mixed rose and ash colour. Elsewhere the skin is a brownish-red, without admixture of green; and the parts of generation have a deep-red colour, as have also, in a less degree, the head and face. The umbilical cord is straight and flaccid. The whole surface is covered with a soapy fluid, so that the body, when handled, slips from the grasp. The cellular tissue is filled with reddened serum, and in parts, especially

in the scalp, with a substance aptly compared to gooseberry jelly. The cavities are filled with an abundant bloody serum, and the minute structure of the viscera, tinged throughout of a reddish-brown colour, is very distinct.

These appearances, more or less marked, as the child has lain a longer or shorter time dead in the womb, cannot be mistaken for those due to any other cause. They are quite distinct from the effects of putrefaction in air or water, and there is no putrefactive odour. But as time is required for their development, they are not present when the fœtus has lain only a short time dead in the womb. The annexed engraving shows the effects of intra-uterine maceration which had proceeded so far as to cause extensive separation of the cuticle, but without decided flattening of the several parts. The skin was of a deep rosy red colour on the body, of a deeper tint on the head, and of a still stronger colour on the parts of generation.

Fig. 18.

The single case in which, anterior to, and independent of, respiration, we may state that a child was born alive, is, when we find marks of violence so severe that they could not have originated during the birth, and attended with hæmorrhage so abundant that it must have occurred while the blood was still circulating; as in a case related by Devergie of an infant that had not breathed, yet was proved to have been murdered, by extensive wounds with copious effusion of blood and marks of

great violence on the head.* To justify a positive opinion, the loss of blood must be large; for considerable hæmorrhage might follow a severe wound inflicted on a plethoric infant after the circulation had ceased.

There are two cases then, in which, independent of, and anterior to, respiration, we may decide the question, "was the child born alive?"—negatively, when we find the marks of intra-uterine maceration; affirmatively, when we discover injuries so extensive and severe, that they must have been inflicted after the birth, and while the blood was still circulating.

But the cases must needs be very rare in which evidence can be obtained, or will be needed, of live-birth before respiration; for very few children in whom the blood is still circulating are born without breathing, at least imperfectly.

In the great majority of cases, then, evidence of live-birth must be sought for in the lungs, proof of respiration being the first link in the chain of evidence that the child was born alive. We have first to show that the child had breathed, and then that the act of breathing took place after the birth; for it may have breathed during the birth, and yet have perished before that complete delivery which constitutes live-birth.

HAS THE CHILD BREATHED?

The best evidence of respiration is the change it produces in the external appearance of the lungs; and, were it not that inflation gives rise to the same change, mere inspection would supersede all other tests. As it is, it serves to establish the alternative of respiration or inflation when all other means fail.

Lungs that have neither breathed nor been inflated are of a uniform firm texture throughout, resembling in colour and consistence the adult liver. Their surface is marked by slight furrows, which obscurely denote the division of the lobules, and are scarcely visible in lungs that are full of blood; but in lungs containing little blood, they are more distinct, and are very marked after intra-uterine maceration. The lungs are also sometimes studded with small melanotic spots of various shapes.

The effect of respiration or inflation varies with its degree. The smallest quantity of air will develop some of the superficial cells, and so prove the admission of air in one or other of these ways. The right lung, and especially the edges and concave surface of its upper lobe, admit air most readily; and here the first effects of inflation or respiration must be looked for.

* 'Annales d'Hygiène,' May, 1837.

The appearance of the air-cells thus developed is highly characteristic. If the lungs are fresh and full of blood, they take the form of brilliant vermilion spots; if the lungs contain less blood, or are examined some days after death, the spots are of a lighter tint; and in children who have survived their birth some days they have very nearly the hue of the healthy adult lung.

Fig. 19.

The form and arrangement of these cells are as characteristic as their colour: they are angular, are not perceptibly raised above, though they are obviously near, the surface of the lung. They are generally in irregular groups, but sometimes in regular and symmetrical batches of four. Their ordinary appearance and grouping is shown in the annexed wood-cut, taken from a coloured drawing of lungs in which imperfect respiration had taken place.*

The only appearances on the surface of the lungs with which these developed air-cells might possibly be confounded are, 1, melanotic spots; 2, spots of blood; and 3, air-bubbles, the product of putrefaction. The first two are easily recognised by their characteristic colour, and the absence of anything resembling a developed texture, and both, as a rule, are round and isolated. They are never seen in regular groups.

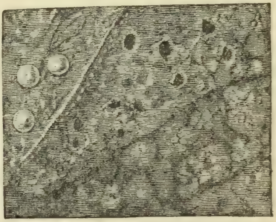
Putrefaction causes appearances quite as characteristic. The air collects on the surface, and between the lobes of the lungs, either in detached projecting globules, the size of peas, or in strings of small vesicles, like a fine mercurial injection beneath tissue-paper. It is evidently contained in the cellular tissue between the pleura and the surface of the lung, and its true situation is often pointed out by a small globule seated on a larger one. If these appearances did not suffice to distinguish air, the product of putrefaction, from air in the air-cells, let the finger be passed over the surface of the lung, when the air will be seen to follow the movement of the finger. A gentle pressure effaces the small vesicles, and even breaks down the larger ones; but no amount of pressure so applied will force the air out of the air-cells, or in any way alter their appearance.

Some authors have enumerated among their objections to the hydrostatic test an emphysema of the fœtal lungs; but this so-called emphysema, being an incipient process of putrefaction, causes the same appearances as the more advanced stages do, and

* I have once seen the air-cells as a group of small globules, like millet seeds, arranged closely side by side, on the same level, and once, too, the developed air-cells like a bright scarlet froth on the rich purple substance of lungs loaded with blood. (G.)

admits of the same ready discrimination. The subjoined engraving (fig. 20) is as faithful a representation, on a somewhat enlarged scale, as it is possible to give, without colour, of the several appearances just described. With the exception of the large air-bubbles, taken from another subject, they were all present on a limited space of the same lung. The air-cells are recognised by their peculiar shape and grouping; the rounded isolated dark spots are melanotic, the fainter spots, effused blood; the string of small light round dots, and the large circular spots, are air-bubbles.

Fig. 20.



The contact of air with the surface of a fresh fœtal lung gives rise to exactly the same change of colour as is seen in the developed air-cells; but it in no way alters its texture.

The appearance of the developed air-cells is, therefore, characteristic; and furnishes undeniable proof either of respiration or of inflation. It is the only lung-test to which no serious objection can be offered; and it is as delicate as it is simple; for it detects a quantity of air too small to affect the specific gravity either of the entire lung, or of its parts. I have repeatedly detected at a glance, in the superficial air-cells, a quantity of air insufficient to render the smallest fragment of lung buoyant; and I have never found these signs of respiration absent in any case in which a child was stated to have breathed, though for the shortest space of time. In one case in which the act of respiration consisted in only three gasps, the result was obvious, at a glance, in the bright vermilion-coloured groups of developed air-cells scattered over the surface of the right lung. (G.)

If respiration did not occasion the same appearance in the air-cells as inflation, and we could infallibly distinguish the one from the other, no other lung-test would be needed.

Now, Devergie,* after stating that a careful examination had enabled him to distinguish, *à priori*, and without any other research, lungs belonging to a still-born infant from those of an infant which had breathed; and also to determine whether the air had dilated all parts of the lungs, or merely certain portions, adds, that "in *many* cases he could determine whether the dis-

* 'Médecine Légale,' art. Infanticide.

tension of the lungs with air was the effect of respiration or of insufflation;" for in respiration there is a minute injection of capillary vessels on the surface of the air-cells, which does not take place in inflation. This distinction may be well founded, but as, according to the author's own statement, it is to be relied on only in *many*, but not in *all* cases, it is unfit for medico-legal use. I have not myself observed such a difference between the effects of inflation and respiration as to pretend to be able in this way to distinguish the one from the other. (G.)

Developed air-cells, then, form the best, and only necessary proof, of the admission of air into the lungs; and they are to be found in every case of respiration or inflation, however limited in extent, or slight in degree.* The number of the cells is, moreover, a measure of the extent to which these processes have been carried. When respiration is complete, the lungs present the same spongy, crepitant character as in the adult, and differ from them only in having a more rosy hue.

Before proceeding to the other lung-tests, we must premise that respiration is not a sudden, but a gradual process; that it is rarely, perhaps never, completed in a few respirations; that it very often remains incomplete and partial after many hours, days, or even weeks; and that in some grown-up persons portions of lung are even believed to retain their fœtal state. In the great majority of cases, therefore, we shall have to deal with lungs in which respiration has been very incompletely set up. Hence the importance of a sign which stands us in stead where other tests fail.

But the admission of air into the cells of the lungs is not the only effect of respiration. As a general rule it is attended by an increased afflux of blood, adding to the weight of the lungs, both when taken by themselves, and when compared with the weight of the body to which they belong. This increase of weight, absolute and relative, has been made the basis of two lung-tests.

Absolute Weight of the Lungs.—This test rests on the assumption the reverse of the truth, that the blood-vessels of lungs which have not respired are empty and collapsed, while after respiration they become more or less filled with blood. This statement of Foderé, has since been corrected by Orfila and Devergie: that it is most erroneous, I can confidently affirm; for I have found lungs which had breathed almost destitute of blood; and others that had not admitted air, or presented only a few groups of developed cells, gorged with blood in every part. (G.)

* This simple sign of respiration was for a long time overlooked, and was certainly misinterpreted; for Cruveilhier, in his 'Morbid Anatomy,' depicts the bright vermilion air-cells as a disease of the fœtal lungs.

The early estimates of weight were in accordance with these mistaken assumptions. The lungs of mature children before respiration were stated to weigh one ounce, or 480 grains; after respiration, two ounces, or 960 grains. How remote these estimates were from the truth, the following averages, founded on upwards of 400 observations on mature children, will show:—Still-born, 874 grains; children who had survived their birth one month or less, 1072 grains. The observed weight, therefore, in still-born children is nearly double the rude estimate of authors; and the increase after respiration, instead of being equal to the original weight, is less than one-fourth.*

The slight effect of imperfect respiration on the weight of the lungs is shown by the following averages founded on a large number of facts:—Still-born, 874 grains; imperfect respiration, 988; perfect respiration, 1195. So that the effect of imperfect respiration is to increase the weight of the lungs by about 100 grains, or one-eighth of their original weight.

Different durations of respiration affect the weight of the lungs as follows:—Still-born, 874 grains; less than one hour, 918; twelve hours, 853; one day, 1000; one month and less, 1072 grains. Hence one hour's respiration adds less than 50 grains to the weight of the lungs, and a whole day's breathing only 126 grains. The fact that the average after 12 hours is more than 50 grains less than the average at the end of one hour is in keeping with a fact often brought under my notice that lungs choked with blood are those in which breathing is often most imperfect. (G.)

If additional evidence were required of the uselessness of this test, it might be found in a comparison of the weight of the lungs in two children born alive with the same weight of body. In the one, the lungs weighed 494, in the other 1544 grains.

The inference drawn from a comparison of average weights is thus fully confirmed by that from the extremes.

It is obvious that the absolute weight of the lungs cannot serve to distinguish respiration from inflation; for inflated lungs, are, as to the blood they contain, in the exact condition of fœtal lungs.

Ratio of Lungs to Body.—Ploucquet's Test.—Before examining this test, we must premise that still-born infants are heavier

* In former editions of this work several numerical comparisons and tabular statements were given; and one especially in this place, which justified the following curious assertion—that out of 34 cases, there is not one in which we could have determined by means of this test alone, whether respiration had, or had not, taken place: that, in two instances, the great weight of the lungs would have led us to infer respiration in still-born infants, while the lowest weight before and after respiration (500 grains) being equal, no opinion either way could have been hazarded.

by about one-third than those born alive; that males are heavier than females; that the ratio of lungs to body decreases as the weight of the body increases; and that the weight of the lungs is even more variable than that of the body.

This test is a good example of the futility of conclusions drawn from a small number of facts. Ploucquet, making use of three facts, only two of which were strictly comparable, happened to obtain the proportion before respiration of 1 to 70; after respiration of 1 to 35. But averages drawn from more than 400 observations on mature children show these proportions: Still-born 1 : 57, instead of 1 : 70; children surviving one month or less, 1 : 38, instead of 1 : 35. The extremes, which are the values required for practical purposes, are almost equally condemnatory of proportionate weight as a test.*

The following are the mean proportions after different durations of respiration:—Still-born, 1 : 57; less than one hour, 1 : 51; twelve hours, 1 : 53; 1 day, 1 : 48; one month, or less, 1 : 38. These differences are certainly much too small to justify the use of the test in cases of imperfect respiration, in which alone it would be required.

If further proof were needed of the futility of this test, it would be found in the fact that, the weight of the body being in each of two children born alive 32,436 grains, the lungs bore to the body in the one the proportion of 1 to 21, in the other of 1 to 66; the first ratio being more than three times as great as the second.

The same remarks, then, apply to both these tests. Simple inspection would render them superfluous even if they were useful; and as they cannot serve to distinguish inflation from respiration, they must be allowed to fall into disuse as alike unsafe and unnecessary.

The Hydrostatic Test.—This test has lost much of the importance once attached to it; but the controversies to which it gave rise, the important purpose to which it was applied, and the high value assigned to it, justify the notice here taken of it. That it may be understood, it must be premised that, though first proposed as a test of live or still birth, it has never been other than a test of respiration: also that since it was first proposed towards the end of the seventeenth century, it has

* In this place, too, a table was given in former editions, which showed that in 7 cases out of 33 there is a probability, derived from the low ratio, that respiration had not taken place; but, on the other hand, one case in which, relying on the high ratio of 1 : 21, we should have mistaken a still-born child for one that had breathed.

undergone several modifications. Originally, and till a comparatively recent period, it consisted in placing the lungs, with or without the heart attached, in a vessel of water of the temperature of about 60°. The first modification consisted in dividing the lungs into several pieces, and dealing with them as with the entire lungs; and the second and last in first immersing these pieces in water, and then submitting them to pressure. This subsidiary test of pressure removes at least one objection to the test as originally performed, though it leaves others in full force, and opens an important inquiry as to the distinction between the effects of respiration and inflation.

We shall consider first the value of the original test with the addition subsequently made of dividing the lungs into several portions, but without submitting them to pressure; and with the distinct understanding that it is not to be taken as a test of live-birth, but only of respiration. A supporter of the test thus applied would assert on its behalf, that, if the lungs, whether entire or divided, when placed in water, sink to the bottom, respiration has not taken place.

To this assertion there are two objections: 1. That respiration may have taken place, and yet both the entire lungs, and all the parts into which they have been divided, may sink in consequence of disease. 2. That respiration may have taken place, but to so limited an extent, or in so imperfect a way, that the lungs and every part of them, though perfectly healthy, and not containing any undue quantity of blood, may sink.

In examining the first objection, it must be borne in mind that disease may exist before respiration, or supervene upon it. If the disease existed before respiration, and does not affect every part of the lungs, the healthy portions would receive air, and, if the quantity of air admitted into them were sufficient, float; if, on the other hand, the disease supervene upon respiration, it is unlikely (though a case of double pneumonia fatal the eighth day, in which both lungs "sank completely even to their smallest particles," is recorded by Casper) that it would consolidate the whole of both lungs. Some portions, therefore, would be found to float. So that, whether the disease occurred before or after respiration, the cases must be extremely rare in which it would constitute a valid objection to the test.

In the case of partial disease of the lungs, the first objection merges in the second; for if lungs healthy in all their parts may respire and yet not float, it follows that the air taken in by healthy portions of diseased lungs may fail to render them buoyant.

The second objection—viz., that respiration may have taken place, but to so limited an extent, or so imperfectly, that the lungs and every part of them, though quite healthy, and containing only the usual quantity of blood, may sink—is valid. A single case will suffice to prove this. In a female twin, weighing little short of five pounds and probably nearly mature, "The substance of the lungs was healthy, of a deep Modena-red colour, with here and there patches of a somewhat lighter hue." There was no crepitation under the knife, nor any congestion.* Both lungs, when placed in water, sank with equal rapidity; as did every one of the fifteen pieces into which each lung was divided; and on compression below the surface no air-bubbles escaped. This child survived its birth twenty-four hours, and the case does not stand alone, for similar ones have been reported by Bernt, Remer, Orfila, Daniel, Schenk, and Osiander.

Billard, meeting with some of these cases, fell into the strange error of supposing, that children may survive their births for hours, and even days, without breathing.† I have myself repeatedly examined lungs in which respiration had been very imperfectly set up in several parts of one or both, and yet only one or two of these parts floated. But I have not met with any instance in which every portion of both lungs sank. (G.)

The two objections, then, to the sinking of the lungs, whether entire or divided, if taken as a proof that the infant had not breathed, are valid as applied to the hydrostatic test in its original form; whether the lungs are healthy in all their parts, or only in portions of their structure.

Suppose now that the lungs, or one or more of the parts, float, and that this buoyancy of the whole lung or its parts is alleged as proof that respiration has taken place. This assertion would be met by three distinct objections:—the buoyancy may be due, not to respiration, but 1. to emphysema; 2. to putrefaction; 3. to inflation.

1. The first objection is easily disposed of. The term emphysema, in its usual acceptation, means an enlargement or rupture of the air-cells caused by air introduced in respiration, or by inflation. Now, air introduced in respiration will so expand the air-cells as to furnish, independent of emphysema, distinct proof that the child has breathed; and, if the emphysema were caused by inflation, the first objection would become identical with the third. But the emphysema urged as an objection to the

* Taylor in 'Guy's Hospital Reports,' No. v. case iv.
† 'Maladies des Enfans,' title Viabilité.

hydrostatic test is quite a different thing, and is supposed to be brought about by some peculiar action of the lung tissues. This was Cummin's opinion.* He thought that infants might suffer injury in the birth through the labour being tedious and the mother malformed; that the sides of the chest might be so pressed against the substance of the lungs as to injure them; that so "they became inflamed and puffy, containing air in large vesicles on their surface, and this is what some authors call emphysema." Lécieux also, in extracting infants by the feet, often found that part of the lungs floated, though the child died in the course of the delivery, and had certainly not breathed. This buoyancy could not be due to putrefaction, for the infants were fresh, and examined soon after extraction; but he thought that, as we sometimes see a wound or bruise, especially on the head, attended by an emphysematous swelling, the lungs during the extraction might suffer a sort of contusion; that blood might be effused into their tissue, might lead to the formation of some bubbles of air, and to the consequent buoyancy of a part of the lungs.†

The true explanation of the formation of air in lungs free from putrefaction is to be found in a simple fact that came under my notice in the winter of 1840. I examined the body of a mature still-born fœtus, within forty-eight hours of its extraction by instruments. There was not the slightest trace of putrefaction in the body or in the lungs; no change of colour, no softening of tissue, no putrefactive odour, and, with the exception of a vesicle the size of a pea on the surface of one of the lungs, no formation of gas. The lungs, which were gorged with blood, were extracted, placed in a gallipot, and carried in the pocket about two hours; at the end of which time their whole surface was found studded with vesicles, some large as a pea, others smaller than a pin's head. In that short space of time a very large quantity of gas was developed, though the lungs had certainly sustained no injury in the birth, and no single sign of putrefaction could be detected.‡

* 'The Proofs of Infanticide Considered,' by William Cummin, M.D., p. 61.

† Lécieux: 'Considérations Médico-légales sur l'Infanticide.'

‡ On referring to Casper's Handbook (vol. iii. p. 68) it will be seen that he only wanted such a fact as this to complete his exposure of the weakness of the grounds on which this objection of emphysema has been made to rest. His criticisms certainly warrant the statement "that not one single well-observed and incontestible case of emphysema developing itself spontaneously within the lungs of a fœtus, born without artificial assistance, is known, and it is not, therefore, permissible in forensic practice, to attribute the buoyancy of the lungs of new-born children, brought forth in secrecy and without artificial assistance, to this cause." The words "without artificial assistance," introduced to meet the case by Hecker, to which Casper attaches undue importance, would have been rendered unnecessary by a knowledge of the *experimentum crucis* described above, and now nearly 40 years old. (G.)

This incipient putrefaction, for it is nothing less, is not limited to the lungs, but occurs in effusions of blood on the brain (of which I have seen two examples) and in parts of the body containing an unusual quantity of blood. The lungs in which it occurs are usually congested, or the seat of the pulmonary apoplexy which is so apt to occur in tedious labours, or in infants extracted by instruments. (G.)

This so-called emphysema being, therefore, merely incipient putrefaction, the first objection to the floating of the lungs as proof of respiration, merges in the second; and instead of three objections we have two: 1. The formation of air in the cellular tissue from putrefaction incipient or advanced: and 2. Inflation.

1. *Putrefaction.*—The possibility of the lungs floating from putrefaction, was formerly questioned, but without reason. The real origin of the doubt is shown by some experiments which I made in the winter of 1839. The lungs of some still-born children, when placed in water, as soon as putrefaction set in, rose gradually to the surface, remained there several days, and then slowly sank to the bottom. In others, large air-vesicles formed on the surface, but not in number sufficient to render them buoyant; in others, again, though they gave out a strong putrefactive odour, there were no air-vesicles, and no rising to the surface, nor did they ever float either in the water in which they had stood, or in fresh water. (G.)

There is no doubt, then, that gases developed in the various stages of putrefaction cause lungs that have not breathed to float. This objection to the original hydrostatic test is therefore sometimes valid.

2. *Inflation.*—The objection that the lungs may be rendered buoyant by inflation is also valid, as the possibility of so inflating the lungs as to cause them to float, is universally admitted.

To the Hydrostatic Test, then, as originally applied, and used merely as a test of respiration, there are four valid objections; two to the sinking of the lungs as a sign that respiration has not taken place, and two to the floating as a proof that it has; to the sinking as a proof of non-respiration, disease, and imperfect respiration; to the floating as a proof of respiration, putrefaction (in its several degrees and stages), and inflation.

The Hydrostatic Test modified by Pressure.—The mode of applying pressure is not material, provided it stops short of destroying the lung texture. Air, the product of putrefaction, is readily expelled by the finger; but if stronger pressure be required, the fragment of lung may be placed in a clean cloth, and the cloth twisted opposite ways. In experiments presently to be

described, the fragments of lung were submitted to still stronger pressure by treading the cloth under foot (G.).

A supporter of the hydrostatic test, in this its modified form, would assert on its behalf, that if the lungs, both entire and divided, when placed in water, sink, both before and after being submitted to pressure, respiration has not taken place. The objections to this assertion are the same that apply to the earlier test, viz., disease and imperfect respiration; but with this difference, that portions containing much blood and too little air to render them buoyant, might possibly float after part of the blood had been forced out, and the texture flattened. Hence the sinking of the lungs after pressure, would afford a stronger reason for supposing that respiration had not taken place.

But if the several portions of lung float, both before and after pressure; and this buoyancy be taken as a proof of respiration, do the two objections urged with success against the earlier test, viz., putrefaction and inflation, hold good against this modern test also?

The objection on the score of putrefaction falls at once to the ground; for the mere pressure of the fingers expels the air generated by putrefaction, and causes the lungs to sink. There remains, then, the single objection of inflation.

That air introduced into the lungs by inflation will render them buoyant, there can be no doubt; but whether pressure will distinguish the buoyancy due to respiration from that due to inflation is a question that demands very careful consideration.

The addition of pressure to the old hydrostatic test was suggested by Béclard, and introduced into practice in this country by Dr. Taylor,* and Mr. Jennings,† both of whom employed it as a diagnostic mark. The former concludes from repeated experiments, "that air, introduced by artificial inflation, may, under all circumstances, be expelled by compression, if the experiment be properly performed, and the pressure continued a sufficient length of time."‡ Mr. Jennings states, "that air introduced into the lungs by artificial inflation, may be expelled by pressure, so that the lungs will sink in water," and on the other hand, that "after respiration, the air cannot be expelled from the lungs without completely breaking down the structure of every part of the organ. Any part, however small, not thus broken down, will continue to float."

This statement of Mr. Jennings respecting respired air is cor-

* 'London Med. and Phys. Journal,' Nov. 1832, and Jan. and May, 1833.
† 'Trans. of Prov. Med. and Surg. Association for 1833.'
‡ 'Guy's Hospital Reports,' No. v.

rected by Dr. Taylor, on the authority of Case III. in the Essay cited.* This case proves "that air, from respiration" (imperfect respiration), "may, by very moderate pressure, be forced out from divided portions of the organs;" while Case II. shows "that there are no satisfactory means of distinguishing artificial inflation from feeble respiration." Schmitt also reports a case in which only the middle lobe of the right lung of an infant that had lived twenty-four hours, and in which inflation had not been practised, floated, and that imperfectly, but sank again when forcibly compressed.†

This test, then, does not distinguish imperfect respiration from imperfect inflation. On the other hand, my experiments made in the year 1841 prove that lungs completely distended by inflation cannot be made to sink by pressure short of that which destroys their texture; and that lungs so distended with air differ from those that have breathed completely only by requiring somewhat more pressure to make them sink.

I subjoin an account of one of these experiments from notes taken at the time:—

"I took the lungs of a child two months old who had died of marasmus, and the lungs of a fœtus, still-born at eight months. I inflated the fœtal lungs completely, and in doing so ruptured the air-cells, and produced emphysema over the entire surface, so that when I ceased to inflate them, the lungs rapidly collapsed. I then took one lobe from the lung of either body, and, placing them together in a cloth, submitted them, by means of an assistant, to strong pressure. Both portions still retained their buoyancy. I next stood on the cloth, and repeatedly stamped on it, but still both floated, though their structure was almost destroyed. I then took a portion from the lungs of both children, distinguishing the lung which had breathed by the darker colour of its central portion, placed them both together in the same cloth, and proceeded as before. After applying pressure by twisting the cloth strongly, both pieces continued to float; they retained their buoyancy even after they were trodden on, and it was not till they were pounded with the heel, and their structure thoroughly broken up, that the inflated portion sank; the portion of the lungs which had breathed still floated, though imperfectly. On pounding this portion of lung a second time, this likewise sank. A second and a third experiment led to the same result, the inflated portion of lung sinking after a *less* degree of

* The child survived six hours, and breathed very imperfectly.

† Schmitt, 'Neue Versuche,' &c., 93rd observation, p. 217.

pressure than the portion which had breathed, but the structure being in both portions broken up before their buoyancy was destroyed." Another series of experiments yielded the same result (G.).

If, in these experiments, pressure, short of that required to break down the structure of the lung, had caused the inflated portions to sink, while the portions that had breathed did not sink till their structure was destroyed, we could understand how *pressure* might become a means of diagnosis; but as the only difference is one of degree, and as, in any given case, we have to examine a portion of lung separately, and not side by side with one which we can take as a standard of comparison, it is obvious that this test is not applicable to medico-legal purposes.

It has been objected that these experiments, made on lungs inflated out of the body, do not admit of application to the case of lungs inflated within the body. This objection, of which it is difficult to see the validity, has happily been obviated by experiments upon lungs successfully inflated within the body. Two such cases, of which one was reported in the 'Medical Times,' Nov. 30, 1844, were communicated to me by Dr. Henry Browne, of Manchester, and two similar cases, by Dr. F. J. Hensley, were published in the 'Medical Times,' Feb. 8, 1845. All these children were still-born, and the lungs were extensively inflated; but they could not be made to sink by pressure till their structure was broken up* (G.).

The only objections, then, to the hydrostatic test, coupled with such pressure as will dispel the products of putrefaction, are three:—1. The lungs may sink, and yet the child have breathed; for the respiration may have been too imperfect to render any part of them buoyant. 2. The lungs may sink, though respiration have taken place, in consequence of disease. 3. The lungs may float, and yet the child not have breathed, in consequence of inflation.

The following additional tests of respiration have been proposed:

* This statement, made more than a quarter of a century ago, has been since confirmed by Casper. He says: "It is quite incorrect to suppose, as has been done, that the air can be easily *forced by compression* out of lungs artificially inflated, but not out of those which have respired, or, at least, that it is more easy to do so in the former case than in the latter. Both of these ideas are perfectly erroneous, as I have been taught by innumerable experiments, renewed every session in the course of my lectures. The air contained in the pulmonary cells, in whichever of these modes it has been introduced, can never again be expelled, even by the employment of the utmost violence, as by standing with the weight of the whole body upon a piece of lung, &c.; and the portion of lung thus forcibly compressed, floats almost as well after its compression as before it."—Handbook, vol. iii. p. 67.

but though corroborative of other evidence, they have no independent value.

Changes in Size and Shape of Chest.—The chest before respiration is stated to be small, narrow, and flattened; after respiration to be larger, and rounder. This test is not wanted in cases of complete respiration, while in imperfect respiration the presumed changes do not occur. It is needless in the one case and useless in the other.

Change in Position of Diaphragm.—The diaphragm, before respiration, is stated to be arched and to rise high in the chest; after respiration, to be flattened and depressed. This sign is open to the same objection as the foregoing.

Increased Volume of the Lungs.—The lungs are stated to be more bulky after respiration; this increased size being due partly to afflux of blood, but mainly to admission of air. This test is condemned by what has been already said of the static lung-tests. It also is needless when respiration is perfect or extensive, and useless when imperfect.

Altered Position of the Lungs.—Before respiration, the lungs lie far back in the chest, leaving the thymus and pericardium uncovered, and presenting sharp edges; after respiration they project forwards, seem to fill the chest, nearly cover the thymus and pericardium, and have rounded edges. This is a description of fœtal lungs and of those that have fully respired: it is inapplicable to cases of imperfect respiration; for, in all these points fœtal lungs closely resemble those that have breathed imperfectly.

Altered Consistence of the Lungs.—Before respiration, the lungs are dense as liver; after respiration, spongy and crepitant. When they are spongy and crepitant, they have, of course, received air; but that air may have been either inflated or breathed. In imperfect respiration, the change in the lungs does not extend beyond the limits of the developed air-cells.

Weight of Liver compared with Weight of Body.—After respiration, part of the blood which had circulated through the liver is diverted to the lungs. The liver, therefore, loses weight. Bernt, of Vienna, availed himself of this fact to encumber the subject of infanticide with another useless test; and Orfila took the needless pains to submit it to experiment. All the objections already advanced against the static lung-tests, and all that might be urged against any test whatever, apply to this.

To all the foregoing tests, then, there is one simple objection—when respiration is complete they are needless, and when imperfect, useless; and they do not distinguish inflation from respira-

tion, which is the only information not obtained by the first glance at the surface of the lungs.*

A careful examination of the lungs themselves is the best and only necessary means of determining whether or not they have received air through the air-passages. If the air-cells are developed, it can only be by respiration or inflation, and the number of cells so developed is the best measure of the extent to which those processes have been carried. The eye detects these signs of the admission of air where the quantity is too small to render any portion of their texture buoyant.

The practical directions for determining the question of respiration are, therefore, very simple. Proceed at once to extract the lungs, taking care not to injure them or the surrounding organs: examine them closely, and if they have throughout the colour and texture of the adult liver, respiration has not taken place; but if the surface is mottled with bright vermilion or rose-coloured spots, and these spots contain developed air-cells, then respiration or inflation has taken place.

The resemblance then of the effects of inflation to those of respiration is the only difficulty which we encounter in ascertaining whether a new-born child has, or has not, breathed. This difficulty cannot be overcome by any lung-test, but it may be materially lessened by some very obvious considerations.

It is now generally admitted that the lungs of an infant may be inflated through the mouth, without the aid of any instrument. All that is needed is to secure the nostrils, to force the windpipe back on the gullet, and to imitate the movements of respiration by alternately compressing and releasing the chest. Four instances of such successful inflation are referred to at p. 115 of this work. Schmitt succeeded more than once† in completely inflating the lungs in this way; in two so perfectly, " that not even a single point was to be found in either lung into which the air had not penetrated."‡ Such complete inflation is not readily effected even out of the body; for I have repeatedly removed the lungs, and inflated them by the blowpipe, and in no case have I been able to expand their entire texture without rupturing some of the superficial air-cells (G.). It is not easy, therefore, even for an instructed and skilful person, to effect a

* The refinements of balances and graduated jars, with which some German authors have encumbered the hydrostatic test, may be safely consigned to oblivion.

† Op. cit. Experiments lxxx. and xcviii., also x. xliii. and xlix.

‡ Elsässer, as quoted by Casper, was far from successful in his attempts to inflate the lungs of the dead infant without opening the chest or abdomen.

complete expansion of the lungs; and it may be safely affirmed that such complete inflation could not be practised by an unskilful one. If, then, it were urged on a trial for infanticide, that the mother had tried to save the life of her child by inflating its lungs (for the supposition that this might be done maliciously to criminate the mother is simply absurd), and it appeared in evidence that the lungs were completely expanded, the plea must fall to the ground. But even if the lungs were found very imperfectly distended, it admits of grave doubt whether this could be effected by an uninstructed and unpractised female recently delivered.

But to make this plea of inflation by the mother feasible, she must have shown her anxiety to preserve the life of her offspring, at least by making some preparations for her delivery, and preparing clothes for her child. In the great majority of cases of alleged infanticide, no such preparations have been made; and the plea of inflation would be still less tenable in that large class of cases where the child's body bears marks of violence.

Many attempts have been made to distinguish inflation from respiration. Metzger gives no less than four diagnostic marks, and states that inflation is distinguished by incomplete distension of the lungs, by flatness of the chest, by absence of crepitation when the lungs are incised, but chiefly by their bloodless state, such state not being accounted for by previous hæmorrhage. All these distinctions are unfounded; for imperfect respiration also produces incomplete distension with flatness of chest, and absence of crepitation; and these may coincide with a bloodless state of the lungs. The static lung-tests have also been used as means of diagnosis; but as they do not distinguish respiration from non-respiration, and inflated lungs are, as concerns the blood they contain, in the state of lungs which have not breathed, the static lung-tests may be pronounced useless for this purpose.

There is fortunately one available distinction on which little stress has been laid. In all unskilful attempts to inflate the lungs through the mouth, air passes in considerable quantity into the stomach; so that its absence from that organ would go far to prove that inflation had not been practised.*

If, now, by careful inspection of the lungs, we have convinced ourselves that respiration has taken place or inflation been practised; that the stomach does not contain air, and that the circumstantial evidence, strengthened by general considerations respecting the difficulty of inflating the lungs, renders the plea of inflation un-

* Casper points out as signs of inflation, crepitation on incision without escape of blood-froth, rupture of cells, a bright cinnabar red colour without marbling, and (perhaps) air in the stomach and intestines. Vol. iii. p. 68.

tenable, and leaves no alternative but that the infant had breathed, a further inquiry is still needed before we can assert that it was *born alive*, in the sense the law attaches to that term. The question still to be answered is:—Did the infant breathe before, during, or after birth?

Respiration may take place before complete delivery, *a.* in the womb; *b.* in the passages; and *c.* after the delivery of the head.

a. Respiration may take place in the womb in cases of face-presentation; but this is a rare event, occurring only once in 280 deliveries. In this position, too, respiration would be extremely imperfect, so that any considerable expansion of the lungs would at once negative the supposition of the child having breathed within the womb, and perished before complete delivery.*

b. Respiration may also occur during the passage through the vagina; especially if the hand is introduced to facilitate tedious labour, or change the position of the child. It must also be admitted to be possible in the absence of manual assistance, when the parts of the mother are capacious; but in these cases, too, respiration would probably be very imperfect, so that a considerable distension of the lungs would negative the supposition of respiration having occurred only in the vagina.

c. Respiration after delivery of the head, and before complete separation of the body from the mother, is a common event. In such a case there is not likely to be any serious impediment to complete delivery. Schmitt relates no less than nine such cases which occurred in his own practice, and in all of them the child was born alive. On the other hand, a few cases are recorded in which children having breathed in this situation perished before the completion of the labour; and this may happen to children breathing in the womb or in the passages.

The possibility of respiration before complete separation is thus placed beyond a doubt: and it is evident that the mere inspection of the lungs would not enable us to assert positively that respiration took place before, during, or after the birth. But if the lungs are found fully or even largely distended, with air, it will be safe to assume that respiration had not taken place only in these situations, but that the child was born alive.

But we may succeed in obtaining better evidence of live-birth than the state of the lungs can afford, by a careful examination of other parts of the body;—of the stomach, intestines, and bladder; of the organs of circulation, umbilical cord, skin, and middle ear.

* With regard to this "vagitus uterinus"—this respiration in the womb, as a fact of practical value in cases of infanticide, Casper expresses a very justifiable scepticism. Vol. iii. p. 40.

As the changes in the organs of circulation, umbilical cord, and skin, are both proofs of live-birth, and means of determining how long a child has survived, they will be reserved till the indications afforded by the state of the internal viscera have been considered.

The *stomach* in still-born children, according to Tardieu, is lined with a glairy mucus free from air-bubbles, but after respiration contains saliva and air-bubbles swallowed during the establishment of respiration. Later it may contain milk or farinaceous food, proving that the child was born alive, and had lived long enough to be fed. Milk is readily identified by its physical characters, by the microscope (see figs. 12 and 13, p. 84), and by Trommer's test, as used for detecting the presence of sugar in urine.* Farinaceous food may be identified by the starch it contains, which has characteristic appearances under the microscope, and strikes with iodine-water a blue colour; and by Trommer's test if the food has been sweetened. The presence of blood in the stomach also affords a probability of live-birth, for it is more likely to have been swallowed than to have been poured into the stomach as the result of disease.

The large *intestines*, in mature still-born children, are filled with meconium; and though this may be partially expelled during labour, a considerable quantity remains in all cases of still-birth. Its complete expulsion, therefore, would furnish a strong probability that a child had survived its birth. But on the other hand, the presence of a considerable quantity in the intestines does not prove the child to have been still-born, as its expulsion is sometimes delayed for some hours or days.

Breslau says that the intestinal canal of still-born children contains no gas, and that the occurrence of gas in the canal is not dependent on the presence of food, but due to the act of respiration. It shows itself first in the stomach, possibly from the swallowing of air during inspiratory efforts, and gradually extends along the intestinal canal. In proportion to the duration and completeness of the respiration does the gaseous distension manifest itself. Liman, who has put this test to the proof in several cases, thinks that the fact of the intestinal canal of a fresh infant being found distended with air, may be held to favour the idea of live-birth; but when the body has undergone putrefaction, it is not to be relied on, nor in cases where the indications of respiration are obscure. See, however, Inflation, p. 112.

* Trommer's test. Add to the liquid to be examined a few drops of a weak solution of sulphate of copper, and caustic potass in excess, and apply the spirit-lamp. The liquid assumes a deep violet tint, and on being further heated deposits red suboxide of copper. This test gives characteristic results with the whey and curd of milk, as well as with liquids containing sugar.

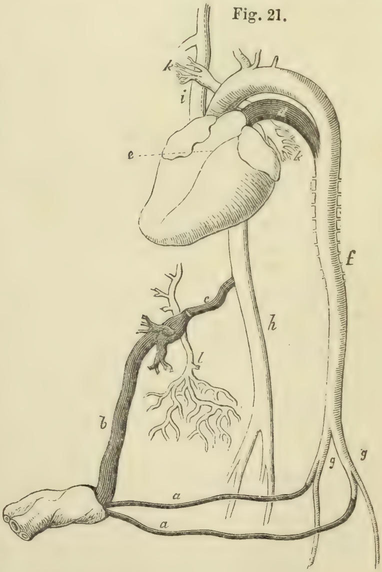
The *bladder* is commonly emptied of its contents soon after birth; hence, if found empty, it has been assumed that the child was born alive; if full, that it was still-born. But this sign is most fallacious, for the bladder may certainly be emptied of its contents during labour, and replenished should the child survive its birth some time. The statement of Casper that he has "unnumbered times" found a *full bladder* and an empty rectum, or the reverse, deprives these signs, taken together, of any value they might be supposed to possess.*

The point of ossification in the lower epiphysis of the femur, spoken of in the note to p. 90 as a test of age, may be admitted among the signs of survivorship. But it must have a very limited application.

III. HOW LONG DID THE CHILD SURVIVE ITS BIRTH?

Our means of answering this question are less precise than could be desired. The extent to which respiration has taken place cannot be depended upon; and recent observations have tended greatly to impair the value of at least one of the three signs just referred to, namely — *a.* Changes in the organs of circulation; *b.* The state of the umbilical cord; and *c.* The state of the skin.

Fig. 21.

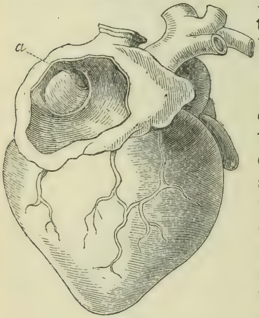


a. The Organs of Circulation.— There exist in the fœtus certain temporary additions to the organs of circulation destined for extra-uterine life. These consist of the umbilical arteries (*a a*), which return the

* A uric acid infarction of the straight tubules of the kidneys in new-born

blood of the fœtus to the mother; the umbilical vein (*b*), which conveys the blood of the mother through the intervention of the placenta, to the fœtus; the ductus venosus (*c*), which conveys part of the mother's blood direct to (*h*), the ascending cava; the ductus arteriosus (*d*), which conveys the blood destined after birth to circulate through the pulmonary arteries (*k k*), direct into (*f*) the descending aorta; and the foramen ovale (*a*, fig. 22), situated at (*e*), which, by establishing a communication between the right and left auricle, makes the double heart of the future breathing animal, a single one during the life in the womb. All these parts, being unnecessary to extra uterine life, are closed after birth.*

Fig. 22.



The Umbilical Arteries and Vein.—The obliteration of the *arteries* takes place much sooner than that of the vein. At the end of twenty-four hours they present a marked contraction and thickening of their coats near the umbilicus. At the end of two days the contraction extends through a great part of their length, and at the end of the third day nearly reaches their termination in the iliacs. In the *umbilical vein and ductus venosus*, during the first three days, there is only a slight contraction; on the fourth this is more marked, and on the fifth it is, with few exceptions, complete.

The changes in the *ductus arteriosus* have been minutely described by Bernt. The vessel is about an inch long, and as large as the pulmonary artery. After a few respirations it contracts towards the aorta, but after some hours or days uniformly throughout. At the end of a week it has shrunk from the size of a goose-quill to that of a crow-quill; and on the eighth day is obliterated in half the children, and about the ninth or tenth in all.

children, first described by Vernois, was at one time considered by Virchow and others as a sign of extra-uterine life, and conditioned by the establishment of respiration. This, however, has been shown to be erroneous by the occurrence of similar deposits in the kidneys of fœtuses which have undoubtedly never breathed.

* In the diagram at p. 121, *g g* represent the iliac arteries, *i* the descending cava, and *l* the vessels of the portal system, derived from the umbilical vein.

The period of obliteration of the *foramen ovale* is extremely variable. Thus Billard found it closed in 1 out of 18 infants of a day old; in 4 out of 22 of two days; in 3 out of 22 of three days; and in 2 in 27 of four days old. Devergie also takes note of the uncertain period at which the foramen is closed. It often continues open even in the adult, and, in some cases, without any dangerous consequences.

Bernt gives minute but useless details respecting the situation of the opening of the fossa ovalis at different intervals after birth. Indeed, the confidence formerly placed in the closure of the several fœtal vessels and of the foramen ovale, as signs of live-birth, and in their order and progress of obliteration, as means of determining, with some approach to accuracy, how long a child had survived its birth, has been lately rudely shaken; for it has been shown that, on the one hand, all the vessels and the foramen ovale may be found open in children who have lived several days; and, on the other, that even the ductus arteriosus and foramen ovale may be closed within a few minutes after birth, and, in rare instances, previous to it.

Of the patency of the fœtal vessels after live-birth, a good example is given by Mr. Henry Lee, in his 'Pathological and Surgical Observations,' p. 116. The umbilical vein, ductus venosus, ductus arteriosus, and left umbilical artery, were all open, the right being closed only near the umbilicus, and yet the child from which the preparation was taken died from umbilical hæmorrhage when a fortnight old, and six days after the separation of the funis. Similar cases have been reported by Jörg and others. On the other hand, the little importance which attaches to the closure of the fœtal vessels and foramen ovale is shown by a case reported, by Dr. Norman Chevers, to the Pathological Society, January, 1847. The child had lived only fifteen minutes, and yet the ductus arteriosus was found uniformly contracted so as only to admit the shank of a large pin, while its coats exceeded in thickness those of any other large vessel. Dr. Chevers thought that the contraction took place before birth; an opinion which receives some countenance from the fact that the duct has been found absent. Of the very early closure of the foramen ovale, a remarkable case was reported by Mr. Smith, at a later meeting of the same Society (Dec. 7, 1847). The child died comatose at the end of sixteen hours, and the foramen ovale was found closed by a strong reticulated membrane firmly attached to its distinct annulus, impervious, and pouched. Dr. Chevers inclined to the opinion that in this case, also, the closure had taken place before birth.

The open state of the fœtal vessels and foramen ovale is therefore no proof of still-birth; and, on the other hand, the contraction of the ductus arteriosus and closure of the foramen ovale are quite consistent with a very short period of survivorship. So that the medico-legal value of these tests is nearly on a par with that of the static lung-tests. The open state of the vessels affords a low probability of still-birth, and the contraction or closure of one or more of them of live-birth; but not of the length of time that the child has survived its birth.

b. Changes in the Umbilical Cord.—In a new-born child the umbilical cord is fresh, firm, round, and of a bluish colour; its vessels still contain blood; and its size varies with the gelatinous fluid it contains. The *shrinking, withering,* or *mummification* of the cord is the first change: it commences at the ligature, and gradually extends to the navel. In some cases it begins directly after birth; in others not till the lapse of some hours; it is rarely delayed beyond thirty hours or two days, and never longer than three. The cord is now flabby, and sometimes a distinct red circle is perceptible round its insertion, with inflammatory thickening and slight purulent secretion. The second change is *desiccation.* The cord first assumes a reddish-brown colour, and becomes semi-transparent, it is then flattened and shrivelled; and when the process is still more advanced it becomes quite transparent, and of the colour of parchment, the umbilical vessels being contracted, and containing clotted blood, or they are completed obliterated. This process of desiccation sets in from one or two to four days after birth, and may be complete in from one to five days, but the usual period is three days. The next stage is the *falling off* of the cord: this usually happens on the fifth day. *Cicatrization* of the umbilicus, the last change, takes place about the tenth to the twelfth day. This description is based chiefly on the observations of Billard.

The changes in the cord of a child born dead, are merely the common consequences of putrefaction. Desiccation does not occur till after the latest period at which it takes place in the cord of a living child; and the cord does not separate, though the cuticle can be readily peeled off. Casper has shown that the first change (mummification) is not a vital process; but that it happens with portions of the cord cut off and exposed. He does not, therefore, attach to it "the slightest value as a proof of extra-uterine life!" But he considers the bright red ring surrounding the insertion of the cord, with inflammatory thickening, and slight purulent secretion, as affording "irrefragable proof of the extra-uterine life of the child." This red line

requires to be distinguished from a narrower circle found in still-born children.

c. Change in the Skin.—This consists in an exfoliation of the epidermis, in scales, or as a fine dust, beginning on the abdomen, extending successively to the chest, groins, axillæ, interscapular space, and limbs, and ending with the hands and feet. It may begin when the child is a day old, but may be delayed till the third or fourth day. It lasts, also, a variable period—of thirty days or two months, and longest in feeble and delicate children.

This, too, is a vital process, differing essentially from that separation of cuticle which takes place in consequence of putrefaction. Although the period of its occurrence is variable, its existence affords clear proof that the child has survived its birth.*

d. State of the Middle Ear.—In the fœtal condition the middle ear does not contain air, but is filled up by a sub-epithelial mucous or embryonal connective tissue. Wreden,† supported by Wendt,‡ has founded on the disappearance of this tissue a test of respiration and extra-uterine life. Its disappearance varies somewhat with the activity of the respiratory process. In general it is entirely gone, and its place taken by air twenty-four hours after birth. If the tissue exists, it is argued that respiration has not occurred; if it is entirely replaced by air, respiration is proved; if instead of air the cavity contains amniotic or other fluid, this is an indication of active respiratory efforts in the medium which fills it.

From an examination of 38 cases in reference to these statements, Dr. F. Ogston§ concludes that the absence of the mucous tissue is pretty sure indication of respiration, but that the time of its complete disappearance varies from a few hours to two or three weeks.

The following table, based on Billard's observations, presents, at one view, the principal changes just described, the probable date of their occurrence, and the proportion of cases in which the foramen ovale and ductus arteriosus have been found open:—

* Billard: 'Maladies des Enfants,' pp. 13-24.
† 'Vierteljahrsch. f. Gerich. Med.' xxi. 2. 1874, p. 208.
‡ 'Arch. d'Heilkunde,' xiv. 2. 1873, p. 97.
§ Ogston's 'Lect. on Med. Jurisp.,' p. 242.

Days.	Umbilical Cord.	Foramen Ovale. Open per cent.	Ductus Arteriosus. Open per cent.	Umbilical Arteries.	Umbilical Vein.	Ductus Venosus.
1	Withering.	74	68	Open.	Open.	Open,
2	...	68	59	Obliterated.	Open.	Open.
3	Desiccating.	64	68	Obliterated.	Open.	Open.
4	Separating.	63	63	...	Contracted.	Contracted.
5	...	45	52	...	Obliterated.	Obliterated.
8	Separated.	25	15			
10 to 12	Cicatrization commencing. Complete.					

The two questions—1. Was the child born alive? and, 2. If born alive, how long has it survived its birth? having been answered, we may have next to inquire,

HOW LONG HAS THE CHILD BEEN DEAD?

Post-mortem changes occur in the same order in the infant as in the adult. The animal heat first disappears, rigidity then ensues, and putrefaction follows. The body of the new-born infant cools very quickly; the rigidity is less, and does not last so long as in the adult; and putrefaction, according to Devergie, goes on more rapidly, facts which will have to be borne in mind in applying the principles laid down in a future chapter. (See Putrefaction.) The effects of intra-uterine maceration (p. 102) must not be confounded with those of putrefaction.

CAUSE OF DEATH.

There are several ways in which the life of a child may be sacrificed, within a short period of its birth, without violence on the mother's part: *a.* It may be immature or feeble; *b.* It may encounter obstacles to the continuance of respiration; or, *c.* a congenital disease may shorten life.

a. The death of an infant after a few respirations, in spite of the most skilful and persevering attempts to restore animation, is an event well known to every accoucheur; and must be a common occurrence in children born under circumstances which preclude

effectual assistance. The most common causes of early death are a long and tedious labour, hæmorrhage, continued interruption to the circulation through the cord; and immaturity or feebleness. The causes, too, which occasion still-birth promote the early death of children born alive. Thus, more large infants perish in the birth, or die soon after, than small ones, and more males (as being larger) than females; and more in a first pregnancy than in subsequent ones. Illegitimate children in the absence of violence, or of intentional neglect, would seem to be specially liable to be still-born or to die soon after birth; the reports of obstetric practitioners show that, while the mortality of legitimate children is about 1 in 20, that of the illegitimate is about 1 in 10; the deaths of males being to those of females as about 7 to 5.

b. The chief obstacles to the breathing are the contact of the infant's mouth with some soft and yielding object, with blood, the discharges, or water; and the accumulation of mucus in the mouth, nostrils, and air-passages. Respiration may also be prevented by the child being born in the membranes.

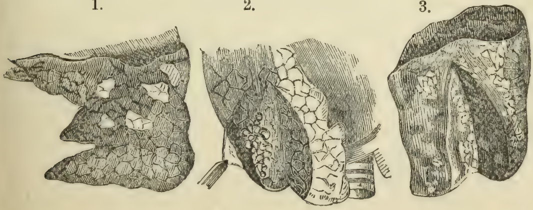
c. The congenital diseases that prevent the establishment of the vital processes, or render their continuance for any length of time impossible, have their seat in the three organs most essential to life—the heart, the lungs, and the brain.

Diseases of *the heart and large vessels* are rare in infancy; but contraction, or early closure, of the fœtal vessels (p. 123) affords a presumption of death from natural causes.

Diseases of the *lungs* are more important. Of these the following are the chief: 1. Hepatization (red and grey), the consequence of pneumonia before birth. 2. Pulmonary apoplexy. 3. Tubercles. 4. Œdema. 5. A disease described by Devergie, as œdema lardaciforme. And 6. A state known as atelectasis. The three conditions of atelectasis, pulmonary apoplexy, and œdema lardaciforme are illustrated in portions of lungs in the annexed figure, of which 1. shows atelectasis as figured by Jörg. 2. The œdema described and

Fig. 23.

1. 2. 3.



figured by Devergie. And 3. Pulmonary apoplexy from a child three weeks old, one of several infants of the same family, that had died about the same age from embarrassed respiration.

These diseases may affect the whole lungs or a part only. In the first case, respiration cannot be perfectly established, nor the child long survive its birth; when, however, the disease is partial, it shortens life in proportion to its extent.

The state of lung to which Dr. Jörg of Leipsig gave the name of *atelectasis* or imperfect expansion, is not, strictly speaking, a disease, but an absence of respiration and persistence of the fœtal state found to a greater or less extent in most new-born children, and continuing for days or weeks. The lungs in the unexpanded parts are perfectly healthy.

The chief diseases of the *brain and spinal marrow* are apoplexy, accumulations of fluid, and morbid softening. The apoplexy of the fœtus and new-born infant differ in no respect from that of the adult. M. Lasserre (Ranking's 'Retrospect,' vol. iii. p. 342) gives a case of meningeal apoplexy, a second of effusion of blood into the ventricles, and a third into the back part of the left hemisphere. A small quantity of serum between the membranes or in the ventricles, may be disregarded, but a considerable accumulation would afford a sufficient explanation of premature death. In estimating the effect of morbid softening of the brain and spinal cord as a cause of early death, it must be borne in mind that the brain of the fœtus is naturally soft and vascular.

Of all these diseases it may be remarked that they are of rare occurrence; that they do not often exist to such a degree as to account for speedy death; and that it is only when proofs of respiration are present that they have any significance.

In children who have survived their birth but a short time, the absence of marks of violence affords a fair presumption of death from natural causes. It is true that death may have happened through intentional neglect—from the want of those simple appliances by which the lives of children in more favourable circumstances are preserved—or by the simple closure of the mouth and nostrils; but these causes of death leave no distinct marks behind them, and the accused must have the benefit of the doubt that attaches to the case.

Was the Death due to Violence?—As fatal injuries may be the result of accident, it is only in extreme and exceptional cases that we can say without hesitation that they were due to murderous violence. Punctured wounds of the fontanelles, orbits, heart, or spinal marrow; dislocation of the neck; separation of the head from the body; extensive fracture of the bones of the head

and face; suffocation by plugging the fauces; or strangulation effected with unusual force tell their own tale. But there are other cases in which the nature and cause of the injury can only be determined by reference to obstetric experience and medico-legal experiments, illustrating the mechanical injuries a child may sustain during the act of parturition or immediately afterwards.

Suffocation.—Respiration, as already stated, is sometimes prevented or arrested by accidents which leave no mark of injury; so that it cannot be stated whether the child fell into the position of danger, was intentionally placed in it, or was allowed to remain there when it might have been rescued. This difficulty presents itself in the not uncommon occurrence of the case of a child found in a privy, when the question arises whether it was suffocated by being thrown in, or expelled while the mother was there for a natural purpose. In such a case, respiration, extensive or complete, affords a strong presumption against accident; very imperfect respiration an equally strong probability the other way.

Many cases of sudden parturition in such situations are on record; but they are rare in women who have not previously borne children. Jörg relates the case of a pregnant woman, who "on account of a desire to evacuate the bowels, went to the night-stool, and brought forth sitting on this, without any pain or bearing-down, a large boy, who first struck the edge of the night-stool with his head, and then fell on the ground."* There was extravasated blood on the left parietal bone. Mr. Tatham also mentions the case of a married lady delivered of twins on the night-stool. It was not her first labour, but probably her second. Both children died.† It is *possible*, then, that a fœtus found in a privy may have been suddenly discharged and suffocated. If the child so expelled fall into water instead of into night-soil (and generally when an infant is found in water), a question arises whether death was due to drowning, or the child was placed in the water to conceal some other mode of death.

Suffocation by such matters as mud, straw, feathers, wool, and wet linen thrust into the mouth, is not an uncommon cause of death. Whether the foreign substance could have been drawn into the mouth with the breath, or was intentionally introduced, must be determined by its quantity and compactness.

Infants are sometimes suffocated by rolling the tongue back

* 'Die Geburtshülfliche Exploration,' p. 116.

† 'London Medical Repository,' vol. i. part iv. New Series.

into the throat. But as it would probably resume its usual situation, it is unlikely that this cause of death would be detected.

Strangulation.—A child may be strangled by a cord, and yet no marks appear on the neck. But even when there is a discoloured depression round the neck, it is not certain that this was caused by the mother; for it might arise from the twisting of the navel-string, or by the pressure of the neck of the womb. Klein, indeed, affirmed that he had never met with ecchymoses or sugillations produced by the orifice of the uterus, or by the umbilical cord, though he had known a great number of cases in which the neck of the infant had been strongly girded by the funis once or twice twisted round it, so as either to produce strangulation or to render it imminent. But a case mentioned by Jörg shows that the experience of Klein is not to be implicitly trusted:—"The navel-string had been twisted five times round the neck, and had left five tolerably deep red impressions." Taufflieb also has reported cases of the same kind,* and there are several English cases to the same effect.

The mark of the navel-string is broad, continuous, grooved, rarely single, not excoriated, but sometimes consisting in parts of bloody extravasations. The contraction of the neck of the womb produces a broad depressed livid stripe.

The presumption of strangulation by the navel-string has, of course, no place when the cord is very short; for though its usual length is that of the body itself (say 18 inches), it may be as short as $4\frac{1}{2}$, and as long as 69, inches. (Churchill.)

Marks of pressure on the neck, then, are not always due to intentional violence; but as a murderer generally uses more force than is needful, they are too distinct in homicidal cases to be attributed to accident; and if the cord itself were used as a ligature, it would probably be applied with undue force. The complete establishment of respiration, again, affords the strongest presumption against strangulation having been produced by a cause acting during the birth, just as the absence of signs of respiration affords a presumption in favour of the constriction having been due to a cause acting before the birth.

But the twisting of the navel-string round the neck does not always occasion a fatal compression: for it appears from facts industriously collected in Germany that death attributed to this cause occurs in only about 1 in 38 of the cases—results in striking contrast to those that follow prolapse of, and consequent pressure on, the cord, which is fatal in more than half the cases.

* 'Annales d'Hygiène,' vol. xiv. p. 340.

But even when the cord is tightly drawn round the neck, death may not result from simple strangulation, but from interruption to the circulation through the cord. This, however brought about, occasions efforts at inspiration to which Casper attributes the ecchymoses of the lungs, described at p. 110, and the filling of the air-tubes with liquor amnii.*

Strangulation may also be effected by the pressure of the fingers on the throat, leaving bruises corresponding with the cause.

Drowning.—The signs of this form of death are the same as in the adult. They will be described in a future chapter.

Fracture of the Skull.—This may happen:—1. Within the womb. 2. During labour. 3. By falls. 4. By criminal violence.

1. From cases cited by Casper (vol. iii. p. 109) it may be inferred that fractures of the fœtal skull may be occasioned by falls of the mother from a considerable height. Such fractures have, however, from the nature of the case, no medico-legal interest.

2. That the skull may be fractured during labour is proved by many well-authenticated cases. Siebold relates the case of a female with very narrow pelvis, delivered, without assistance, of a well-formed still-born female child. On examining the head, a great quantity of blood was found on the surface of the cranium, and there were three fissures in the left parietal, and one in the left half of the frontal, bone. Michaelis of Kiel also reports the case of a woman with a well-formed pelvis, who was delivered of her first child after a natural labour. The child breathed during and immediately after birth, but then died. The head was much disfigured; and the right parietal bone, which during birth had been directed under the promontory of the sacrum, was covered in front and above with effused blood, and on the removal of the periesteum was found fractured in five places. The whole of the bone was uncommonly thin. On opening the skull there was no extravasation beneath the fissures, but the longitudinal sinus was ruptured, and there was an extensive coagulum on the cerebrum on both sides, under the dura mater, and on the tentorium.† These two cases show how great an amount of injury the head may sustain during birth. But, as a general rule, fractures that take place during parturition are mere fissures, mostly situate on the parietal bone, at right angles to the sagittal suture; but less frequently in the frontal bone, when they take a direction parallel to the suture. They are not attended by ecchymosis or laceration of the scalp.

Between these fractures of the skull and such as are the result

* See Casper's Handbook, vol. iii. p. 125.

† These cases are quoted by Beck, Art. Infanticide.

of intentional violence, there is no essential difference, except in those cases in which unusual violence is used, and the fractured bone is minutely comminuted and depressed; or is not limited to the parietal and frontal bones, but extends to other bones of the skull, and even to those of the face. Defective ossification might explain the occurrence of fissures and fractures, without the necessity of assuming intentional violence.

3. Fractures of the skull caused by falls have been illustrated by some important experiments and observations. Chaussier found that in twelve out of fifteen still-born children let fall from a height of 18 inches on a stone floor, one or both of the parietal bones was broken. The same number of fractures occurred when the height was 3 feet and upwards, and in a few the injury extended to the frontal bone.*

But certain facts collected by Klein render it doubtful whether fracture ever occurs in sudden labours from falls on the floor. He procured returns of all such labours occurring in the kingdom of Würtemburg. They amounted to 183 well-authenticated cases, in 150 of which the mothers were suddenly delivered standing; yet there was not a single death among them, nor fracture of the skull, or other mischief; though some of the children had fallen on bare boards, some on stones. The reason of the difference between Chaussier's experiments and these cases is supposed to be that, in the latter, the body of the infant is projected† obliquely, so as to break the fall. But cases reported by Casper show that the sudden expulsive power of the uterus must be set off against the causes that tend to break the fall. In no less than five instances the child is described as having been *shot* from the mother, and in one of them to have been *fatally injured*. In rare instances, again, the height of the child's fall may exceed that of the distance from the genitals of the mother to the ground. The conclusion which Casper draws from his reading and personal observation is as follows:—"A parturient female may be surprised by the last act of birth in every position, even when erect, that the child may be thus forcibly expelled from her genitals, and may be thereby injured, particularly on its head, and that even fatally." (Handbook, vol. iii. p. 133.)

From facts collected by Dr. Cohen von Baren, it may be inferred that the occurrence of fracture of the skull is largely determined by the state of the cord. Out of his 50 cases, 30 were born while the mother was standing, 17 while stooping or sitting,

* 'Considérations Médico-légales sur l'Infanticide,' par Lécieux.

† Casper, it should be observed, takes exception to many of the returns on which these statements of Klein are founded.

and 3 while kneeling. Of the 50, 32 were first-born, and 42 at full term. Of 19 infants born while the mother was standing, one only had fracture of the skull, and the cause of this was doubtful. But out of 25 cases in which the cord was ruptured, 5 presented fractures of the skull. Fractures occasioned by falls can be distinguished only by the comparatively slight amount of injury which attends them from those due to intentional violence. When we find comminuted fractures of several bones—the parietal, frontal, and occipital—we are justified in attributing them to murderous violence.

When the umbilical cord is torn, it generally does not exceed, or it even falls short of, the usual length, and the seat of the rupture is usually within one or two inches of the navel. If the cord is not torn, but cut, it may be inferred that the injuries to the head were not due to accident. In any case, the state of the cord should be ascertained.

4. Fractures of the skull by intentional violence are characterized, as a general rule, by the undue force employed.

Fracture and Dislocation of the Neck.—These injuries are never present before birth; and as they are not caused by falls, they may be taken as sure signs of criminal violence.

Contusions.—In reference to bruises on the head it must be borne in mind that, as compression of the head during labour occasions a livid swelling, such an appearance must not be attributed to criminal violence.

Incised and Punctured Wounds.—There is nothing peculiar in these wounds when inflicted on the new-born infant. For the distinction between them and other injuries inflicted during life and after death, the reader is referred to the subject of Wounds.

Poisoning.—This is a rare cause of death in new-born infants, though several cases of homicidal poisoning by the mineral acids have occurred in young children, characterized by the same appearances on the body and clothes as mark the action of those acids in the adult. It should, however, be understood that in new-born children the alimentary canal, in common with other important organs, is subject to disease. The lining membrane of the *œsophagus* may present red spots, longitudinal lines, or ramifications, which, if arranged transversely, might be mistaken for the effects of a ligature applied to the neck. *The stomach,* moreover, as well as other parts of the alimentary canal, may be the seat of ulcerations with a sanguinolent, dark-coloured discharge. The rules for the examination of the stomach and intestines, and their contents, are the same for the infant and adult; and will be treated under the general head of Poisoning.

Infanticide by Omission.—The omission to tie the umbilical cord may prove fatal; and there can be no doubt that it is sometimes a criminal act. Fodéré relates a case in which the child perished from the ligature becoming loose;* and Dr. Campbell reports two fatal cases, one from the accidental, the other from the intentional, removal of the cord.†

But the testimony of Klein and others that fatal hæmorrhage rarely follows *rupture* of the cord, proves that it is not necessarily the act of the mother; but may occur, as already stated, in sudden delivery in the erect posture.

The signs of death by hæmorrhage are the paleness of every part of the body, coupled with the small quantity of blood in the heart and large vessels. In the absence of wounds, this state may be regarded as probably the effect of hæmorrhage from the cord.

The child may perish by other acts of omission. The mother may not have provided proper clothing or food, or she may fail to remove it from a position of danger, and to clear the mouth of mucus, or other accidental impediment to breathing. Death from want of food betrays itself by extreme emaciation, and the empty state of the alimentary canal; and death by starvation and cold combined by pallor of the surface, with internal congestion.

Cases of infanticide by omission are difficult of proof; and even when there are marks of violence on the body, the inquiry is apt to assume so complicated a shape, that the jury cannot be induced to return a verdict of wilful murder.

EXAMINATION OF THE MOTHER.

The first inquiry with reference to the female suspected of having giving birth to the child is,—Whether she has been recently delivered, and if so, whether the period of her delivery corresponds with the time at which the child is supposed to have been born. (See Delivery, p. 82.)

Another inquiry is sometimes necessary; and that is into the state of the mother's mind. Puerperal insanity is not a rare disease, and it may take the form of homicidal mania, threatening the life of the child, as in the following case quoted by Paris and Fonblanque.‡ A married woman, of good reputation, was delivered of a child, and not having slept many nights, fell into a temporary frenzy, and whilst alone killed her infant; but company coming in, she told them that she had killed it and *there* it lay. The good reputation she had previously borne, the long want of sleep,

* Vol. iv. p. 515.

† 'Introduction to the Study and Practice of Midwifery,' p. 151.

‡ 'Medical Jurisprudence,' vol. iii. p. 129.

and the entire absence of the usual motives to such a crime, added to "many circumstances of insanity appearing," led to her acquittal. Dr. Paris observes, in reference to this case, that "had this woman been of doubtful character, though innocent, she might have been executed for want of medical evidence to prove the nature and frequency of puerperal insanity."

A question of some importance in its bearing on infanticide, and having reference to the mother, is whether a female recently delivered, has the strength requisite for the destruction of her child. The answer is in the affirmative. Thus, Foderé relates the case of a French widow, who being seized with labour pains while receiving a visit from eight of her neighbours, complained of colic, and seating herself on a bucket in bed, as soon as the child's head passed the vagina, squeezed it flat by compressing it with her thighs. That a woman has strength enough to move about and exert herself after her delivery, is proved by the successful concealment of the fact of delivery, and of the dead infant, in the majority of cases brought to trial; as well as by well-authenticated instances of females walking several miles, or resuming laborious occupation, on the very day of their delivery.

This subject of infanticide will be best brought to a conclusion by the following summary of the chief points to be attended to.

1. Examine the body of the child to determine its degree of maturity; weigh and measure it, ascertain the position of the centre of the body; and attend to the several points comprised in the description of the growth and development of the fœtus (p. 88); and note any malformation that may be present.

2. Ascertain the time that has elapsed since the death of the child, by the presence or absence of animal heat and rigidity, the existence or non-existence of putrefaction, and, if putrefaction be present, the degree to which it has advanced.

3. Examine the entire surface of the body with a view to discover marks of violence, and, if any be present, determine whether they might have been produced during birth, or by accidental causes acting afterwards. Examine the mouth for foreign bodies introduced into it, and the fontanelles, orbits, heart, and nuchæ, in search of wounds inflicted by pointed instruments. Note the state of the umbilical cord, measure it, and ascertain whether it has been torn or cut; and observe the condition of the skin.

4. Open the chest, and remove the heart, lungs, and thymus gland. Separate the lungs, and carefully inspect their surface. Observe whether they are of a uniform liver-colour and compact consistence throughout, or uniformly spongy like the adult lung, or mottled with developed air-cells, as in imperfect respiration.

If there are parts of a lighter colour than the rest, observe whether the texture of the lung is developed in those parts, and distinguish the developed cells from air the product of incipient or advanced putrefaction, by applying gentle pressure with the finger. In lungs free from putrefaction, the hydrostatic test may be resorted to, to ascertain their degree of buoyancy, as a rough measure of the quantity of air they contain.

5. Examine the heart and foramen ovale; the ductus arteriosus and venosus; and the umbilical arteries and vein. Observe whether these parts are contracted, and to what extent; or obliterated; and whether they contain much or little blood.

6. Examine the stomach to ascertain if it is collapsed or contains air and saliva; whether the child has been fed, using for this purpose the tests for sugar, milk, and starch; if there is any appearance of inflammation in the alimentary canal, test its contents with a view to the discovery of poison. Note whether the intestines contain air, and meconium, and in what quantity, and whether the urinary bladder contains urine.

7. Examine the bones of the skull both at vertex and base, in search of fractures. Inspect the brain and its membranes, and note any effusion of blood or serum. Examine the middle ear. Examine the spine with a view to the discovery of dislocation or fracture of the vertebræ.

8. Examine the suspected female in order to ascertain whether she has been recently delivered, and how long. In certain cases, inquire into the state of the woman's mind.

LEGITIMACY.

A child born in wedlock is presumed to have the mother's husband for its father; but this presumption may be rebutted by evidence of non-access, or of impotence.

There are several circumstances out of which the question of legitimacy may spring. 1. A woman may bear a child after her husband has been absent more than nine calendar months; and in this case the question arises, Does the period of utero-gestation admit of being extended beyond this, the *usitatum tempus pariendi?* 2. A woman within a short period of her marriage may bear a child capable of being reared, and here the question arises what is the earliest period at which a viable child may be born? 3. A woman before the expiration of nine calendar months from her marriage, say in the 7th or 8th month, may be delivered of a child having the size and appearance of one at full term; and the question arise whether being apparently so mature, it could have been of the supposed age. 4. A woman may give birth to

a child during the life-time, or after the death of her husband, he having been at the date of the conception in such a state of feebleness or disease, or imperfect convalescence from some severe malady, as to raise the question whether he could have been the father of the child. 5. A husband dies suddenly in perfect health, and shortly after his death his wife bears an immature child, and after an interval a second at full term or approaching maturity: was the second child the issue of a superfœtation? A question of paternity may also arise, where there is no doubt of the child's legitimacy, through the marriage of the mother to a second husband immediately after the death of the first. For cases of disputed legitimacy turning on the alleged impotence of the husband, see "Impotence," p. 49. The questions which fall to be examined in this place are chiefly—1. *The Duration of Pregnancy.* 2. *The Viability of Children.* 3. *Superfœtation.*

I. DURATION OF PREGNANCY.

Though the practice of our courts of law is to consider forty weeks as the more usual duration, evidence is allowed to be given as to the possibility of that period being extended.

The period of utero-gestation in the human subject is generally stated at 9 calendar months, 10 lunar months, 40 weeks, or 280 days; and we often meet with the less definite expression "9 months, or 40 weeks." But there is a material difference between 9 calendar months, and 10 lunar months, 40 weeks, or 280 days; for 9 calendar months may consist of 273, 274, 275, or 276 days, falling short of 280 by from 4 to 7 days.

Another source of inaccuracy springs from the uncertainty attaching to the means we have of fixing the date of conception. These are *four* in number. 1. *Peculiar Sensations* attending conception. 2. *Cessation of the Catamenia.* 3. *The Period of Quickening:* and 4. *A single Coitus.*

1. *Peculiar Sensations attending Conception.*—This mode of reckoning is open to the objections that these sensations are not so defined as to be recognised at a first conception; that they are not constant in their occurrence in the same female; and that they do not take place at the exact time of the conception.

2. *Cessation of the Catamenia.*—To this mode of reckoning there are the obvious objections, 1. That the discharge may cease from causes other than conception; so that a woman in whom this has happened and who conceives immediately before or after the next suppressed period, may date the conception from the first period. 2. A woman may menstruate once or more than once, after conception. In the first case the reckoning would

exceed, in the second it would fall short of, the true duration. 3. That at the best it can give only an approximate result; for if we assume 28 days to intervene between the commencement of one menstrual period and that of the next, there may be an interval between the termination of one period and the beginning of the next of nearly 28, say 24 days. If conception be assumed to take place on the day *following* the cessation, and we reckon from the suppression, the calculation would fall short of the real duration by 24 days. If, on the other hand, we assume conception to take place on the day *preceding* the cessation, and we reckon from the last appearance of the menses, the calculated would exceed the real duration by the same period of 24 days. To avoid this possible error of 24 days, the expedient has been resorted to of dividing the interval into two parts, and reckoning from the division, thus reducing the possible error to 12 days. When the interval is contracted, either by the menses continuing for several days or recurring every three weeks, or every fortnight, the possible error would be less; and when prolonged to five or six weeks, or even two months, greater.

3. *Period of Quickening.*—This starting-point is sufficiently condemned by the fact that when perceived, it occurs at variable periods, having a range of at least six weeks (from the 12th to the 18th), and if we combine the statements of several authors, of sixteen weeks, namely, from the 10th to the 26th.

4. *A Single Coitus.*—This is the only accurate mode of reckoning; and well-attested facts of this class have been collected in number sufficient to prove that the duration of pregnancy is subject to much variation, and to a marked excess above 280 days. Fourteen such cases yield an average of 284, a minimum of 270, a maximum of 293 days: a range therefore of 23 days, and an excess above 280 days of 13; and 17 to 20 above 9 calendar months.

The inference drawn from cases of single coitus, is strengthened by analogous cases, in which the sudden death of a husband, or the date of separation from his wife, is used to determine not the exact but the minimum duration of pregnancy, conception being assumed to have taken place on the very day of death or departure. 27 cases in which the duration was thus fixed by single coitus, or by sudden death or departure of husband, gave an average of 284, a minimum of 260, and a maximum of 308 days.* The range was therefore 48 days, the excess above 280

* The case of 308 days was supplied by Mr. Hewitt, a former pupil of King's College. The duration was ascertained by the sudden death of the husband. Cases of less than 260 days are excluded.

days 28, and the excess above 9 nine calendar months 32 to 35 days.

There is, therefore, the strongest reason to regard the period of utero-gestation as variable and not fixed; and also to expect increased divergence with an increase in the number of facts.

These views derive the strongest confirmation from the analogy of animals. Formerly their period of gestation was also held to be fixed; and it was stated to be 11 calendar months in the mare, and 9 in the cow. But this is now ascertained to have been an error.

The well-known observations of M. Tessier, which extended to 102 mares and 160 cows, give the following striking results:—

Shortest:—	Mare	311 days.	Cow	241 days.
Longest . . .	„	394 „	„	308 „
Range	„	83 „	„	67 „
Excess above stated period	„	57 or 60 „	„	32 or 35 „
Average period .	„	11 mths. 10 „	„	9 mths. 10 „

Earl Spencer made a still more extensive series of observations on 764 cows,* with these results:—

Shortest period (calf living)	220 days.
Shortest period (calf reared)	242 „
Longest period	313 „
Range (calf living)	93 „
Range (calf reared)	71 „
Excess beyond 260 days, before which time a calf was deemed immature	53 „
Excess above 9 calendar months . . .	37 or 40 „
Excess above 10 lunar months	33 „
Average duration	284 or 285 „

The majority of instances of gestation protracted beyond the average period occurred in the case of bull-calves, the numbers being of cow-calves 90, of bull-calves 152.

These observations of M. Tessier and Lord Spencer prove that the period of gestation in the cow and horse, which, like that of the human subject, was formerly regarded as fixed, is not only variable, but that the extremes are widely separated, and the longest period in excess of the average by considerably more than a calendar month.

The case in favour of a variable period in the human subject admits of being strengthened by other arguments. All the

* See the 'British and Foreign Medical Review' for Jan. 1841.

functions of the human body that have been carefully examined, such as the cutting of the teeth, the pulse, the respiration, are found to vary within wide limits. So also with the functions more directly connected with pregnancy: the catamenia may appear at any age, from 9 years, or earlier, up to 23 or 24, or later; may continue up to any age from 35 to 55, or even later; and recur at intervals of a month, six weeks, or a fortnight, the periods comprising a variable number of days.

Again, the period of quickening varies from the 10th or 12th to the 18th or 20th week, or even later; and child-bearing, which usually ceases by 45, may occur as late as 54, and possibly later.

Another argument in favour of a variable period, and of its possible extension beyond the limit usually assigned, is found in the fact that the advocates of a fixed period are not agreed among themselves what that period is. Of the 17 medical men examined in the Gardner Peerage case, five advocated a fixed period, and opposed the idea of protracted gestation; but all of them, with the exception of Sir Charles Clarke, who fixed it at 40 weeks or 280 days, stated the duration differently, and were forced to admit a greater or less deviation from a fixed standard. Dr. Gooch stated it at from a day or two before to a day or two after 9 calendar months, and Dr. Davis at a day or two under 9 calendar months; while Dr. Blegborough allowed an interval of from 39 to 40, and Mr. Pennington of from 37 to 40 weeks.

But while five of the seventeen medical men supported the opinion that the period of gestation was fixed, or nearly so, twelve believed that it might be protracted to $9\frac{1}{2}$, 10, or 11 calendar months, or (288—290) (304—306) (334—337) days.

The balance of authority, both ancient and modern, may be also adduced in support of the theory of a variable period, and of its possible extension beyond the 280 days.

To the foregoing arguments may be added the fact, that legal decisions in this country have been favourable to protracted gestation, and that the same may be said of the decisions and even of the laws of other countries. Thus the Code Napoleon allows 300, and the Prussian law 302 days, and there has been a decision in the United States in favour of 317 days.*

The period of utero-gestation, therefore, being subject to variation, and admitting of extension beyond 280 days, a question now arises as to the limit of that extension. What is the longest possible duration of pregnancy?

* 'American Journal of Medical Science,' October, 1845.

The 14 cases fixed by a single coitus give a maximum of 293 days; while the 27 based jointly on a single coitus and the death or absence of the husband, extend the period to 308 days. One of two cases by Prof. Simpson brings the figure up to 313 days, and two cases by Murphy up to 314 and 324 days respectively.

The question of the extent to which the period of utero-gestation may be protracted beyond 280 days assumed a definite shape in the celebrated Gardner Peerage case, of which the following is a brief outline.

In the month of March, 1796, Alan Hyde Gardner, afterwards Lord Gardner, a captain in the navy, was married to Miss Adderley; and they cohabited as man and wife till January, 1802 (except during the occasional absence of the husband). On or about the 30th of January, Captain Gardner took leave of his wife, sailed a few days afterwards for the West Indies, and did not return to England till the 10th of July in the same year, his wife remaining in England during the whole of that period. Towards the end of the year 1801, when Captain Gardner was absent on his Majesty's service, his wife entered into an adulterous conversation with Henry Jadis, Esq., which Captain Gardner did not discover till June, 1803; after which time he had no intercourse whatever with his said wife. On the 8th of December, 1802, she was, without the knowledge of Captain Gardner, delivered of a male child, afterwards baptized as Henry Fenton Gardner. In Easter Term, 1804, Captain Gardner brought his action in the Court of King's Bench against Henry Jadis, for criminal intercourse with Maria Elizabeth Gardner, and obtained a verdict for 1000*l.* damages. He also obtained a sentence of divorce in the Consistory Court, and the marriage was subsequently dissolved by Act of Parliament. Baron Gardner died on the 30th December, 1808, leaving Captain Gardner his eldest son and heir, who thereupon succeeded to the barony, as Alan Hyde, Lord Gardner. On the 10th April, 1809, he was married to the Honourable Charlotte Smith, daughter of Lord Carington, and by her had issue an only son, Alan Legge Gardner, born on the 29th January, 1810, and one daughter. Alan Hyde Lord Gardner died on the 27th of December, 1815, leaving Alan Legge Gardner successor to the title. Henry Fenton Gardner attained the age of twenty-one in the month of December, 1823; and Alan Legge Gardner, being an infant of about fourteen years of age, petitioned his Majesty for a recognition of his right to the title by letters patent, or by

ordering his name to be entered on the Parliament Roll as a minor peer.*

It was proved on the trial that there was a possibility of access on the 30th January, of 1802; from that date to the 7th of February, and on or after the 11th of July. Hence the three questions proposed to the medical witnesses:—

1. Could a child born on the 8th of December have been the fruit of sexual intercourse on the 30th of January, being 311 days?

2. Could a child born on the 8th of December have been the fruit of sexual intercourse on the 7th of February, being 304 days?

3. Could a child born on the 8th of December, and living to manhood, have been the fruit of sexual intercourse on or after the 11th of July, a period of 150 days, or two or three days short of five calendar months?

The first two questions may be reduced to one, so as to give the following alternative—if the child were legitimate, he must have been either a 150 days' child, or a 304 or 311 days' child (one calendar month and two or nine days beyond the *usitatum tempus pariendi*). The latter alternative, viz., gestation protracted to the 304 or 311 days, was the one chiefly insisted on. The case was not decided by medical evidence, but by the adultery of the mother of Henry Fenton Jadis, which having been proved, the claim of the petitioner, Alan Legge Gardner, was allowed.†

II. VIABILITY OF CHILDREN.

The question, What is the shortest period of gestation at which a *viable* child may be born? was raised in the Jardine case, which, though less known than the Gardner Peerage case, is equally interesting, as no less than 14 medical men, and a still greater number of non-professional witnesses, gave their evidence. In this case, too, there was great difference of opinion among the skilled witnesses. The evidence of Drs. Alison and Christison was admitted as Lecturers on Forensic Medicine, whose attention had been directed to the question involved; and it may be safely affirmed, that Dr. Christison threw more light upon the case than all the other witnesses put together.

The following is a short abstract of this case:—

The defendant was married on the 3rd of March, 1835; and

* This account is abbreviated from Le Marchant's history of the case.

† For fuller particulars consult Dr. Lyall's summary of the Medical Evidence relative to the Duration of Human Pregnancy, as given on the Gardner Peerage Case.'

on the 24th of August following his wife was delivered of a girl, who, supposing her to have been the fruit of sexual intercourse on the day of the marriage, was only 174 days, or 5 calendar months and 21 days old. The infant, which was undoubtedly immature, though to what degree could not be determined, died on the 20th of March, 1836, having survived about seven months.

The libel charged the defendant with fornication with his wife before marriage. A great many witnesses were called, some to prove the possibility of sexual intercourse before marriage, others to show that the child, though small and feeble, was not immature, or at least not so immature as the date of the marriage would make it; and others to speak to the impossibility or improbability of a child surviving at that early period. The extent to which the allegations of the libel were made good, and the vague nature of the evidence adduced in their support, appear by the following extract from the decision of the Presbytery, November 7th, 1838:—"That the testimony of the several witnesses, both with respect to matters of fact, viz., the appearance of the child at birth, &c., and also with respect to the opinions of medical men regarding the viability of such a premature child as the child in question is said to be, is of such an opposite and contradictory nature, that the Presbytery, with their present light, have great difficulty in coming to any decision on these points. The Presbytery, therefore, agreeably to a common maxim of law, *Satius est impunitum relinqui facinus nocentis quam innocentem damnari*, find the libel not proven."*

The principal points established by the general and medical evidence in relation to Mrs. Jardine and her infant were, that she had menstruated as usual the week before her marriage; that she was, both before and after, in a very weak state; that she was herself a seven months child; that she had a second child, a daughter, which she believed to have been born "just about the commencement of the eighth month of her pregnancy," and that she had not provided baby-linen for this child. As regards the infant, the evidence, though contradictory on many points, showed that it was small (it weighed three pounds when born), very feeble, and decidedly immature, though no data were adduced to show the degree of immaturity. It required to be nursed with care, but not with those extreme

* 'Record of the Proceedings in the reference by the Synod of Fife to the Venerable the General Assembly of the Church of Scotland, in May, 1839, of the case of Mr. Thomas Barclay, Town Clerk, and Nine of the Parishioners of Kinghorn, against the Reverend Fergus Jardine.' Edinburgh, 1839.

precautions for preserving warmth, which were deemed absolutely necessary in the cases of Drs. Rodman and Outrepont, presently to be described.

The special question raised in the Jardine case was this—Could a child born 174 days, or five calendar months and twenty-one days, after marriage, be reared to the age of seven months? and the general question suggested by the case is—What is the earliest period of gestation at which a viable child may be born?

Now it is universally admitted that a child may be born and reared to manhood as early as the seventh month; and as generally believed that a viable child cannot be born before five calendar months, or 150 days.

To test the soundness of this opinion, and to ascertain the earliest date at which a child may be born alive and reared, we must consider two distinct orders of facts. 1. Facts which afford a presumption in favour of early viability by showing that infants born alive at an early period have survived a few hours or days; and 2. Facts of the same order relating to infants that have been reared to adult age, or to such an age as affords reasonable presumption in favour of their having attained that age.

1. To this first class belong such cases as those of Mr. Thomson,* in which an infant of the estimated age of 5 months survived $3\frac{1}{2}$ hours; of Christison,† in which one of 167 days old survived $8\frac{1}{2}$ hours; of Bucholtz,‡ in which one of 189 days old survived 2 days; of Kopp,§ in which one of 182 days survived $4\frac{1}{2}$ days; and of Fleischmann,|| in which one of 168 days survived 8 days.

Dr. Bonnar¶ has compiled a table comprising no less than 112 cases of infants born alive at periods varying from 120 to 210 days; and if from this collection of facts, more or less well authenticated, we omit 39 cases of infants born at 210 days, and about which there need be no dispute, there remain 73 infants born alive at various ages from 198 down to 120 days. Of these 9 had attained ages from 191 to 198 days; 4 had reached 190 days; 3 from 183 to 189; 38 were 180 days old; 3 from 174 to 178; 5 from 165 to 168; 1, 158; 8 of the age of 150 days; and 5, various ages from 120 to 147 days. Out of the large group of infants born at 180 days, 18 survived their birth

* Of Alva, Stirlingshire, quoted by Beck.

† Evidence in the Jardine case.

‡ Beiträge ii. 104.

§ Jahrbuch, iii. 128.

|| Henke's Zeitschrift, vi. 12.

¶ 'A Critical Inquiry regarding Superfœtation, with cases.' By George Lindsay Bonnar, M.D., Cupar Fife: 'Edinburgh Medical Journal,' January 1865.

from 5 minutes to 16 hours; 6 lived one day; 3 from 5 to 11 days; 1, six weeks; 2, four months; and the remainder (7 in number) 1 year, 2 years, and 15 years respectively. Of the 8 infants of the reputed age of 150 days, 2 barely lived, 2 lived 3 minutes; one, 2 hours; one, 24 hours; one, 6 days; and one, 19 years. The group of five cases born prior to the 150th day comprises one of 120 born alive; one of 125 surviving six hours; one of 147, living 12 hours; one of 133 (Rodman's case), 21 months; and one of 135 (Capuron's case of Fortunio Liceti), living to 80 years of age!

2. The second class comprises the three leading cases by Rodman, Outrepont, and Belloc, presently to be more closely examined. Of the facts of the first order it may suffice to state that there is nothing in the accompanying history of weights and measures to militate against the authors' estimates of the period of gestation which the several infants had attained, while, on the other hand, in the Jardine case, the weight of 3 lbs. stated to belong to a child born at 174 days, or before the completion of the 6th month, is a pound in excess of the highest recorded weight; and exceeds the weights given in former editions of this work, with the exception of the very doubtful instance of 3 lbs. 13 oz.

But small length and weight are but two signs of immaturity among several which are at least equally deserving of attention, such as the high position of the centre of the body, the disproportionate size of the head, and wide separation of the fontanelles; the presence of the membrana pupillaris; the non-descent of the testicles; the prominence and deep red colour of the parts of generation; the intense red colour, mottled appearance, and downy covering of the skin; the nails not formed; the scanty deposit, or total absence, of sebaceous matter on the skin; the feeble movements and cries; the inability to suck; the necessity of artificial heat; the almost unbroken sleep; the rare and imperfect discharges of urine and meconium; and the closed state of the eyelids, mouth, and nostrils.

These, on the other hand, are signs of maturity:—

Strong movements and cries as soon as the child is born; the body of a clear red colour, and well coated with sebaceous matter; the mouth, nostrils, eyelids, and ears perfectly open; the skull having some firmness, and the fontanelles not far apart; the hair, eyebrows, and nails perfectly developed; the testicles descended; the free discharge of the urine and meconium a few hours after birth; and the power of suction,

indicated by the seizure of the nipple or a finger placed in the mouth.

By comparing these descriptions with some of the more remarkable recorded cases, we shall see that there is reason to believe in the occasional survivorship of very immature infants. Of the three cases mentioned in group 2, the cases of Drs. Rodman and Outrepont are deserving of special consideration.

Dr. Rodman, after describing the mother as "cautious," "accurate," and trustworthy, and stating that she had borne five children, and "was confident that the period of her gestation was less than nineteen weeks," says, that premature labour was brought on by fatiguing exertions, and that she was delivered of a living male infant.

Not daring to wash the child, it was quickly wiped and wrapped in flannel, with only an opening near the mouth for the admission of air; and then taken into the warm bed with the mother. Though the child was weak, no feeding was attempted till after the lapse of twelve hours. "The nourishing heat with the mother in bed was relied on." The next day, the head, body, and extremities were surrounded with fine cotton-wool, pressed like cloth, to the thickness of two or three rolls, and over that the flannel as before; and again the child was given to the mother in bed. Even with this dress, he could not be kept warm enough; and as he soon became weaker when exposed to the heat of a fire, whilst the warmth of the mother enlivened and strengthened him, he was kept warm, by the mother and two other females lying in bed with him by turns for more than two months. After this he could be left alone from time to time, but was still undressed very cautiously. It was not till he was three weeks old that the length and weight of the body could be ascertained. The *length* was found to be 13 *inches*, the *weight* 1 *lb.* 13 *oz. avoirdupois.* It was extremely difficult to get the child to swallow nourishment the first week; the yellow gum soon came on, and the thrush seized him severely on the eighth day, and lasted till the end of the third week. During the first week he was fed with two or three teaspoonfuls of toasted bread boiled with water, sweetened and strained through fine linen; in the second week twenty drops of beef-tea were added, and small doses of castor-oil were given. At the end of three weeks he began to swallow teaspoonfuls of his mother's milk, which was gradually substituted for the panada, which was still given occasionally with a few drops of port wine. Two days after he made efforts to suck. Under this careful management he attained the age of four months, and his health and excretory functions were

peculiarly regular. Five months after this, as we find from a second paper by Dr. Rodman,* this child was still doing well. In this paper he describes the mother as tall, robust, and healthy, and again states that she had a peculiarly accurate knowledge of the time of her previous gestations, and did not hesitate still to affirm, that the period in this instance was rather under nineteen weeks.†

Dr. James Hamilton, in his evidence in the Jardine case, states that this infant lived a year and nine months; but that from circumstances mentioned to him by Dr. Rodman, he had always thought that there was some mistake in the woman's reckoning, and that the infant was a dwarf, being considerably smaller than those puny infants born within the six months, whom he had seen drag on a miserable existence for four or five days.

It must be admitted that, in this instance, an extremely feeble and immature child was reared by very judicious treatment, and that the mother's estimate of the age was at least as likely to be correct as such estimates ever can be. The length and weight of the child, too, coincide with those stated in the tables given in former editions of this work. The absence of any description of the appearances presented by the child prevents us from determining its degree of immaturity. It might have been a five months' child, but there is no ground for supposing it to have been born before the completion of the fifth month.

The case related by Dr. Outrepont, of Bamberg, is very valuable. The particulars are given so fully, and with such precision, that even Henke, who previously denied the possibility of such an incident, candidly admitted that this case is an unequivocal example of the rearing of a six months' child.‡ The evidence is complete both as derived from the date of impregnation, and from the structure and history of the child. The mother, a young woman, who had always been perfectly regular, menstruated as usual ten days after her marriage, and was subsequently repeatedly connected with her husband. About a fortnight after this menstruation, she became changed in appearance, and, for the first time in her life, had frequent attacks of vomiting and fainting. These symptoms continued, but the catamenia did not return: and about twenty weeks after their last appearance, she felt the first movements of the child. Five

* 'Ed. Med. and Surg. Journal,' vol. xii.

† Case of a child born between the fourth and fifth month, and brought up. By John Rodman, M.D., Paisley, 'Ed. Med. and Surg. Journal, vol. xi. p. 445. The facts of this case were attested by Mr. White of Paisley.

‡ 'Zeitschrift,' vi. 27.

weeks after this she was seized with labour-pains and hæmorrhage; and Dr. Outrepont, having ascertained that this proceeded from the placenta being attached to the os uteri, encouraged the labour, and brought it to a prosperous conclusion. The evidence of this child being not more than twenty-five weeks old, is as strong as it is reasonable to expect. The state of the child at birth was still more unequivocal. It was a boy, and breathed immediately on being born; measured thirteen and a half inches, and weighed one pound and a half. Its skin was covered with smooth lank down, and was much wrinkled. The extremities were extremely small in proportion to the trunk, and were kept constantly bent over the body, as in the fœtus in the womb. The nails of the fingers and toes were like white folds of skin, the testicles were still within the belly, and the pupillary membrane was entire. The child whined but could not cry; slept almost constantly; woke only once a day; seldom opened its eyelids, and was obviously insensible both to light and sound. The first discharge of urine took place on the seventh day, and the first evacuation of the bowels on the ninth. Subsequently the urine was voided once in forty-eight hours, and the fæces every two or three days. The child was placed in a basket filled with wool, kept in a uniform temperature, and moved with great care. For some time it was fed with the spoon on diluted milk and sugar. In four weeks the down began to drop off from the skin. In fifteen weeks the wrinkles had disappeared from the skin, and the length was increased an inch and three quarters. From this time, which corresponded with the fortieth week after impregnation,—that is, with the full period of utero-gestation,—it made rapid advances; sleeping less, eating more, crying strongly, and becoming evidently sensible to sound, and pleased with the light. When fourteen months old, it was of the weight and stature of a child born at full term. In the eighteenth month, the testicles descended into the scrotum. The teeth began to appear early in his third year. He did not begin to walk till half a year later; and then differed from other children of the same age, not only in size, but also in the singularly old expression of his countenance. When Dr. Outrepont saw him in 1816, he was eleven years of age, was as big as a boy of seven or eight, and had just begun to read and write.*

In this case also the length and weight are in keeping with

* This case is taken from Sir R. Christison's evidence on the Jardine case with alterations and additions suggested by the perusal of the case in the 'Zeitschrift fur die Staatsarz,' vi. 19. It may be well to state that Christison admitted the possibility of a child born after 174 days being reared.

those given in former editions of this work, and much within the extremes; and the signs of immaturity are so well marked and so minutely described as to be decisive of the possibility of rearing a child born before the end of the sixth solar month, or 26 weeks.

III. SUPERFŒTATION.

Superfœtation means the conception of a second embryo during the gestation of the first, the products of the two conceptions being born either at the same or at different times.

Some light is thrown upon this question by well-authenticated cases of women delivered of twins of different colours, both fully formed. Beck, on the authority of Buffon, gives the following, as one among many. In 1714, a female at Charleston, in South Carolina, was delivered of twins, within a very short time of each other; one black, the other white. She confessed that on a certain day, immediately after her husband had left his bed, a negro entered her room, and threatening murder, had connection with her. Dr. Moseley mentions the following as occurring within his time in Jamaica, at Shortwood estate:—A negro woman brought forth two children at a birth, both of a size; *one a negro, the other a mulatto.* She stated that she suffered the embraces of a white man belonging to the estate directly after her black husband had quitted her. A case of triplets of three different colours is here omitted as resting on insufficient authority.

These are cases in which the two mature children are brought into the world differing in nothing but colour from children of one father and one conception. There is another class of cases in which the birth of two children is separated by a short interval, or by an interval closely corresponding to their relative size and development, explicable on the supposition of their being twins. The following is cited by Beck, from the *Consilia* of Zacchias:—J. N. Sobrejus lost his life in a quarrel, leaving his wife pregnant. Eight months after his death she was delivered of a still-born deformed child. Her abdomen remained large, and was supposed to contain a second infant, but the efforts made to procure delivery proved fruitless. One month and a day thereafter, the widow was again taken in labour, and brought forth a perfect living child. The relations of the husband contested its legitimacy, on the ground that it was the fruit of a superfœtation, and Zacchias was consulted. He agreed that the two infants could not have been the product of one conception, since the interval between their births was so great: but gave it as his opinion, that the *first* was the product of a superfœtation, and conceived a month after the other. As the husband died sud-

denly while in a state of perfect health, his opinion preserved the mother's character and legal rights. Zacchias seems, in this case, to have chosen the most improbable of two suppositions; for it is certainly more easy to suppose that the birth of twins, the product of the same conception, may take place at different times, than that they should be the products of two different conceptions; and it is difficult to understand on what data he based his opinion that the child first born was the last conceived. In all such questions, the wisest course is to prefer that interpretation which involves the least difficulty, and is most consistent with experience. Now the expulsion of twins at different times is allowed to be a common event, of which examples are to be found in most works on midwifery. The most probable explanation, then, of this case, is that it was one of twins conceived at the same time, but of which one died, and was discharged before the other.

But there are cases which do not admit of so easy an explanation, and which certainly countenance the theory of a double conception.

The wife of Raymond Villard, of Lyons, married at twenty-two, and five years after became pregnant, but had an abortion at the seventh month, on the 20th of May, 1779. She conceived again within a month; and on the 20th of January, 1780, eight months after her delivery, and seven months from her second conception, was suddenly delivered of a daughter. But this delivery was not followed by the usual symptoms—neither milk nor the lochia appeared, and the abdomen did not diminish in size. Two surgeons who visited the female, being at a loss, consulted Desgranges, who declared that she had a second child in the womb. Three weeks after her delivery she again felt the motions of a fœtus; the abdomen again increased in size, and on the 6th of July, of the same year, 1780 (five months and sixteen days after the first birth), she was again delivered of a living daughter. The milk now appeared, and she was able to nurse the child. Desgranges, after stating his firm conviction that these two children were conceived at an interval of some months, adds, that this second child could not have been conceived after the delivery of the first, for no sexual intercourse took place between the husband and wife till twenty days after, which would have made the age of the second child only four months twenty-seven days. On the 19th of January, 1782, the mother presented the two children, with extracts from the baptismal register, before two notaries of Lyons, to attest these facts.*

Assuming the details of this case to be correctly stated, it is nearly conclusive as to the possibility of superfœtation; for if

* Foderé, vol. i. p. 485.

we deny this, and assume both children to have been the product of a simultaneous conception, and the last child to have been at full term, the first (which, be it observed, in common with the other survived its birth between one and two years at the least) must have been born alive at three months and a half; or, if the first child be taken to be seven months old, the second must have been born alive at six weeks. The alternative supposition, that the second child was the fruit of sexual intercourse subsequent to the delivery of the first, is also in the highest degree improbable, for it supposes a child, born before the completion of the fifth month, to be reared, and that without difficulty, and the only remaining supposition, namely, that the second child was a twin born after a gestation of twelve months and a half, presents equal difficulties.

Dr. Maton has also related a well-authenticated case, in which two male children (both "born perfect") were brought forth at an interval of nearly three calendar months. If this had been a case of simultaneous conception, the age of the one would have been six months or less, that of the other nine months or less.

Additional cases are referred to by Beck, in three of which there was an interval of one month, in two an interval of two months, and in one an interval of four months; and Dr. Bonnar cites Velpeau for a case in which an infant "thought to be at full time," was born five months after "a child at the *full time*."

In deciding this question, those cases only must be admitted to have any weight in which the interval between the births is considerable; for, where it is short, if we suppose the child last born to be mature, the first may have been eight or seven months old, which is quite reconcilable with the supposition of its being reared. When, however, the interval is of four months, if we assume, as before, that the child last born is mature, the first cannot be more than five months old, an age at which it is in the highest degree improbable that a child could be reared at all, and certain that it could only be saved by ingenious and careful contrivances of which mention is sure to have been made.

In any cases that may hereafter occur, the size and development of the children should be carefully noted; for even the healthy products of the same conception may differ greatly in size—a fact well illustrated by a case brought under my notice by Mr. Streeter, in which female twins, five and a quarter months old, were born enveloped in a common chorion. I found the one more than twice the size of the other, but the smaller alone had made successful efforts to respire (G.).

If the single case of the wife of Raymond Villard be correctly

stated, the doctrine of superfœtation must be admitted to be established; but it may be useful to subjoin the chief arguments employed by the advocates and opponents of that doctrine.

The opponents of superfœtation allege that the occurrence is impossible, because 1. Shortly after conception the os tincæ, as well as the internal apertures of the Fallopian tubes, are closed by a thick tenacious mucus. 2. The membrana decidua, which is also formed soon after conception, lines the uterus, and aids in obliterating the openings into its cavity. 3. When the uterus is impregnated, the Fallopian tubes, instead of running horizontally to the ovaria, lie parallel to its sides, so that if a second embryo were formed within the ovarium, the tubes could not embrace and convey it to the uterus. And 4. That the second embryo would destroy the first.

The last objection is founded upon a bare assumption, and may therefore be summarily dismissed. The third objection, if valid, must prove fatal to the doctrine of superfœtation; but though this obstacle may exist in the fully-developed uterus, the ovary and Fallopian tubes are not more prevented from coming into contact with each other in the early stage of utero-gestation, at which alone superfœtation is alleged to take place, than in the unimpregnated state. The answer to the first two objections is obvious. The tenacious mucus and the newly-formed decidua, though in contact with the orifices and cells of the uterus, do not adhere so firmly to it as to preclude the passage of the semen. The fact that menstruation in many cases occurs during a part or the whole of pregnancy, seems to prove that the adhesion of this tenacious mucus and of the decidua is by no means so firm as to forbid the passage of fluid; and this argument is strengthened by the frequent occurrence of hæmorrhage in the advanced stages of pregnancy in consequence of partial detachment of the placenta. The arguments advanced against the doctrine of superfœtation are therefore not of such weight as to counterbalance the improbabilities set forth in the case of Raymond Villard; and unless that case can be shown to be untrustworthy, there seems to be no alternative but to admit the truth of the doctrine.

If, now, we admit superfœtation to be possible, Can we explain its occurrence so as to avoid the objections of its opponents? The existence of double uteri, and more rarely of double vaginæ also, suggests the required explanation; and as the recorded cases of this malformation are much more numerous than those of superfœtation, it is quite possible that some of the latter may be explained by the malformation in question.*

* Dr. Cassan ('Recherches sur les Cas d'Utérus Double, et de Superfœta-

That this malformation does really explain some cases of superfœtation, is proved by a case related by Scheider of a woman who, six weeks after marriage, bore a four months' child, and forty weeks after marriage mature twins. The uterus and vagina were both found double, and each vagina had a separate orifice.*

Dr. Bonnar, in the Essay already referred to, raises a novel question of much interest in itself, and obviously admitting of practical application—namely, how soon after delivery may a woman again become pregnant. Starting from the common assumption that at least thirty days must elapse before the uterus can resume its generative function, and adding from 274 to 280 days for the period of gestation, it would follow that no woman could bear a mature child sooner than the 304th, or from that to the 310th day. Dr. Bonnar, by referring to 'Lodge's Peerage and Baronetage,' shows that there have been at least 19 recorded cases in which the interval between one birth and another has been 309 days or less. There were ten cases of 309 to 300 days; 2 of 299 to 290; 4 of 289 to 280; 1 of 273; 1 of 252; 1 of 182; 1 of 173; and 1 of 127 days. Dr. Bonnar, taking these cases into consideration, and weighing the facts relating to the state of the vagina, uterus, and lochial discharge, fixes on the *fourteenth* day after delivery as the earliest at which a fresh impregnation may take place.

Having discussed at length the three leading questions connected with the subject of legitimacy, it will be necessary to say only a few words on some questions of less interest and importance.

The question of paternity, as already stated, may arise when a woman, soon after the death of her husband, marries again. Sometimes this question assumes the shape of the one last discussed. A child is born within five months, or thereabouts, of the death of the first husband, and the question of paternity becomes one of viability. Where the child is of such an age as that it might have had either husband for its father, the paternity must be decided by a reference to the state of health of the deceased husband at the presumed time of conception.

Tenancy by the Curtesy.—A man who marries a woman seised of an estate of inheritance, and has by her issue born alive, and capable of inheriting her estate, shall, on the death of his wife, hold the lands for his life, as a tenant by the curtesy of England. Here the meaning of the expression *born alive*, is not the

ion') has collected 41 cases, in three of which both uterus and vagina were double; and Beck has added 11 others, in three of which the vagina was double.

* Müller's 'Archives,' 1836; and 'London Med. Gaz.' vol. xx. p. 408.

same as in cases of infanticide; for it has been decided that in questions of tenancy by the curtesy any kind of motion, even "a twitching and tremulous motion of the lips," (as in the case of Fish *v.* Palmer, tried in 1806) is sufficient evidence of live-birth.

Inheritance of Monsters.—Blackstone states that "a monster which hath not the shape of mankind," "hath no inheritable blood;" but if, in spite of deformity, "it hath human shape, it may be an heir."

Questions, of little importance and rare occurrence in this country, may arise in slave-holding states, where the reputed parents of a child are of different colours, and the offspring differs in appearance from the majority of children of mixed marriages.

CHAPTER IV.

LIFE-ASSURANCE. FEIGNED DISEASES.

LIFE-ASSURANCE.

MEDICAL men have important functions to perform in relation to life-assurance. Persons wishing to insure their lives are submitted to the inspection and examination of physicians or surgeons selected for the purpose, and their ordinary medical attendants are consulted respecting diseases from which they may have suffered, and their general state of health as far as it has fallen under their observation. Those offices which undertake the insurance of unsound lives, or are ready to accept lives that fall short of the standard of robust health, are specially dependent on information thus obtained. In the best managed offices, again, medical men of standing and experience occupy places on the board, and by affording information respecting the meaning of terms, and the true significance of statements contained in the reports submitted, can render very important service. Medical men have also to report on injuries sustained by persons assured against accident, and to render similar services to benefit societies: also to make similar personal examinations in the case of recruits, emigrants, prisoners, and candidates for employment in public offices.

Most insurance offices provide the medical examiner with printed instructions or a printed list of questions, prepared under medical advice, or suggested by their own experience, relating to the applicant's state of health, his family and personal history, his occupation and habits, whether he has been vaccinated, what attacks of illness he has undergone, and such other particulars as are presumed to affect the probable duration of his life.

Hence the duty of the medical examiner resolves itself into a work of inquiry and a work of personal inspection and examination, respecting both of which a few practical suggestions are here offered.

1. The inquiries which the medical examiner is expected to make relate partly to the family, and partly to the personal, history of the applicant. The first class are chiefly directed to

ascertain the prevalence of hereditary predisposition, whether of a favourable or unfavourable character. As a general rule, the children of those who die old live to be old; while the children of parents who die young are short lived. The medical examiner should, therefore, ascertain what age the parents of the applicant, if living, have attained; if dead, at what age they died; and he should extend this inquiry to brothers and sisters. If the answers respecting these near relatives prove favourable, it will be unnecessary to extend the inquiry further; but if they have died early, or if they appear to be subject to some hereditary malady seriously affecting the duration of life, a larger circle of relationship may have to be included. Having ascertained the ages of the living and deceased members of the applicant's family, the examiner should next inquire into the causes of death* of those deceased members who have not died of old age. If one or more have died of pulmonary consumption, asthma, insanity, gout, cancer, heart disease, or acute rheumatism; of some well-defined scrofulous affection; of apoplexy or with dropsy at an early age; the fact would have to be noted as more or less affecting the value of the life; and similar importance would attach to the ascertained prevalence of any of these diseases among the living members of the applicant's family.

The personal history of the applicant will comprise his age, social relation (whether married or single), occupation, residence, and habits of life; whether he has had small-pox, or been vaccinated, and the diseases to which he has been especially subject. Among the diseases or symptoms of disease to which the greatest importance attaches may be mentioned, spitting of blood (as affording a strong probability of consumption); gout, acute rheumatism, bronchitis, and asthma (both as liable to recur and as laying a foundation for serious organic changes); dropsy (as a common result and indication of severe organic mischief of the important internal organs, heart, lungs, liver, and kidney); inflammation of the lungs (as leaving behind it some unfavourable change in those organs, or as being the direct consequence of tubercular deposit); fits (as betraying serious lesion of the nervous system); rupture (as involving danger of strangulation); calculous disorder and severe urethral stricture (as obviously tending to shorten life); and the syphilitic taint, especially if present in a marked degree.

2. The personal examination will have to be conducted with

* A certificate of the registered cause of death of persons who have died since 1838, when the office of the Registrar-General was first established, may be obtained at Somerset House on the payment of a small fee.

greater or less care or minuteness as the family and personal history have proved favourable or otherwise. If favourable, a cursory inspection and examination will suffice: and if the applicant is well formed; the complexion healthy; the pulse regular and equal, of fair force, and not exceeding 70 or 75, or falling much below 60 (in the female not more than 80); and if the breathing is free and tranquil, the life may be safely recommended for acceptance. But if the family or personal history is unsatisfactory; if the person is ill formed or disproportioned, emaciated or much the reverse; face pale, complexion unhealthy, and the expression anxious; if the pulse exceeds the figures given above, or is otherwise abnormal, and the respiration exceeds 17 or 18 in the minute, or is unequal and irregular; and especially if the applicant has been attacked by any serious disease; a more minute examination directed to the state of the nervous system, of the lungs, of the heart, and of the urinary organs, will be required. The chest should be examined by percussion and auscultation,* and the urine tested for albumen or sugar, and excessive deposits of lithates or phosphates. It is scarcely necessary to add that in these examinations much must always be left to the discretion of the medical examiner. On the one hand, it is his duty to make all needful inquiries and personal examinations; but on the other, to avoid all such questions as savour rather of scientific curiosity than of practical utility.

To these observations on the duties of the medical examiner, we add a brief summary of our knowledge of the influence on longevity, of place of residence, change of climate, occupation and habits of life, peculiarity of constitution, hereditary predispositions, and pre-existing disease.

Place of Residence.—The principal facts that have been ascertained respecting persons living within the limits of their native country are the following:—1. That the inhabitants of rural districts are longer lived than those of towns. 2. That large cities are more fatal to life than small ones. 3. That marshes, low-lying districts on the banks of rivers, and low spots on which the waters of higher lands discharge themselves, are less healthy than more elevated spots. 4. That of two districts of equal elevation, that which has a sandy or gravelly soil is healthier than that which consists of clay or rich alluvium. 5. That close,

* The Spirometer of Dr. Hutchinson was at one time largely used in our insurance offices, but has now fallen into disuse. For a description of this instrument, with directions for its use, tables of reference, and the indications it affords, the reader is referred to Hooper's 'Physician's Vade Mecum.'

damp, and ill-drained houses are peculiarly fatal to life. Such considerations as these ought, in extreme cases, to influence the examiner in selecting lives for assurance.

Change of Climate.—The removal from a temperate or cold climate to a hot one affects the duration of life much more seriously than any change of residence from one part of a man's native country to another. Our insurance offices, accordingly, either refuse to assure lives at all in extreme cases, or demand additions to the usual premium, varying with the ascertained or estimated increase of risk. Reports of the sickness and mortality of our troops and seamen employed in different parts of the world furnish the best information on this subject. From them it appears that while the difference between low damp situations and dry elevated ones prevails everywhere, the risk to life increases with the temperature, attaining its maximum within the tropics, and falling to the standard of England, or even below it, in cold or temperate regions. Some assurance offices, acting on this general principle, allow the assured to reside without extra charge in any part of the world beyond thirty degrees of the equator, requiring from those who take up their abode within these limits an extra payment, roughly proportioned to the additional risk.

Occupation.—The occupations which shorten life are those that lead to excess in spirituous liquors; that combine sedentary habits, or a minimum of exertion, with exposure to a close and heated atmosphere; that entail undue exposure to the weather, with hardships and privations; that require long hours of work, and a sacrifice of natural rest; that are carried on amid irritating vapours, or in clouds of dust; and those that bring men into contact with poisons. The employments which demand special attention, as belonging to these several heads, are the licensed victualler, potboy, and brewers' drayman; compositor, tailor, and drapers' assistant; soldiers and sailors during active warfare; bakers; knife and needle grinders; house-painters, manufacturers of cards enamelled with lead, and men who work with lead, mercury, phosphorus, or arsenical compounds. One occupation not easily brought under any of these heads has been shown to shorten life without causing an undue amount of sickness, namely, the employment of the butcher.

The most important of the above employments, in its bearing on life assurance, is that of the licensed victualler, whose life is always regarded with suspicion, and even deemed uninsurable, in the absence of very distinct proof of temperate habits.

Habits of Life.—Luxury, sloth, dissipation, and intemper-

ance, are very fatal to life; but the last is the only one of which it is easy to obtain distinct proof. When the fact of intemperance is clearly established it affords grounds for peremptory rejection; or in the case of young adults, high premiums based on the probable age at death of the intemperate class.

Unusual risk also attends the assuring of persons living in a continual state of pecuniary embarrassment.

Peculiarity of Constitution.—Under this head it will suffice to notice the scrofulous constitution; the long neck, narrow chest and spare habit so common in consumptive patients; and the short neck, florid complexion, large chest, and tendency to corpulency of the victims of apoplexy.

Hereditary Predisposition.—The most important disease in relation to life-assurance is pulmonary consumption; for it is in a peculiar manner the disease of grown-up men; and especially of young men, and there is no doubt that it runs in families. The inquiries of the medical examiner should, therefore, be specially directed to discover traces of this disease in the family history, and he should attach great importance to the occurrence of several deaths from this cause among the nearest relatives. The importance to be attached to a consumptive history, must be understood to be greater in young men than in older ones. If a healthy applicant has attained an age of 50 or upwards, and has therefore survived the ages at which death by consumption is most common, much less stress would be laid on the family history than if (even though in good health) he were of the earlier age at which deaths by consumption are more frequent. Less importance, too, will attach to a consumptive family history, if (being a male) the deaths from that disease occurred among the females of the family. So also with a small, quick, and frequent pulse, for such a pulse is in a special manner the pulse of pulmonary consumption, and may be the very first symptom to show itself. An unequal or irregular pulse, especially if accompanied by abnormal sounds, may also be important as indicating heart-disease. Insanity, gout, asthma, urinary calculus, heart-disease, dropsy, apoplexy, and cancer, especially when they appear to have caused the death of more than one member of the family at an early age, also merit serious attention.

Pre-existing Disease.—The medical examiner will have to form his own estimate of the influence previous attacks of disease may have had on the health of the applicant and the value of his life. As a rule, mild attacks of the febrile exanthemata, which occur chiefly in childhood, and of typhus or typhoid fever in the adult, do not permanently affect the value of life. But

the more severe attacks of those diseases, as well as attacks of erysipelas, gout, acute rheumatism, asthma, and consumption (which disease often proves fatal after several distinct attacks) must be differently viewed, partly on account of their liability to recur. Among symptoms, that of spitting of blood, taken as an indication of consumption, is of special importance. The expectoration of a considerable quantity of vermilion-coloured blood would always warrant the rejection of a life; but even a scanty discharge of blood, whatever its colour or the part from which it is alleged to come, must be regarded with suspicion, leading to minute and careful examination of the chest. The discharge of a large quantity of dark-coloured blood by vomiting is also important as a symptom of diseased liver. Inflammation or other severe disease of the lungs, or repeated attacks of bronchitis, figuring in the previous history of the applicant, would also lead to a careful examination of the chest, for these diseases are important in themselves, and may be the result of tubercular deposit, or lay the foundation for fatal disease of the heart.

If the applicant's family and personal history, and existing state of health, prove favourable, his life would be recommended for assurance on ordinary terms; but if unfavourable, the somewhat difficult question arises whether the life should be altogether rejected, or accepted with a greater or less addition to the ordinary premium, or (what amounts to the same thing) on payment of the premium required for a healthy person of a more advanced age. Such adjustments can only be safely made under the advice of well-informed and experienced medical men. That the practical results so attained are satisfactory may be inferred from the experience of the Eagle Insurance Office as set forth by their actuary, Mr. George Humphreys. It appears that an average addition of 7 years for applicants whose personal or family history shows a liability to diseases of the organs of respiration, or to heart disease, has proved sufficient, and that the same addition has sufficed for such persons of intemperate habits as have not seriously suffered from them; also that an addition of 6 years has sufficed for suspicious family history and obesity, 4 for gout, and 3 for hernia, It should, however, be borne in mind that these are *average* additions, and that the number of years added is greater as the applicant is younger. Thus, if we take one cause of addition with another the figures for successive decades beginning with that of 20, were 9, 8, 6, 5, 4, 3, and 3. As a general rule the more advanced ages, demanding as they do a higher premium, require a smaller addition of years.

But the medical examiner may be required to give advice respecting proposals for insurance on unsound lives for short periods, and to suggest the terms on which they ought to be effected; for it may be of the utmost importance to effect an insurance for one or two years on a life which must be rejected if offered for a longer term. A young person, for instance, who has already had symptoms of pulmonary consumption, and whose chest has been ascertained to be unsound, may desire to insure his life for one year, and the examiner may have to report on the expediency of undertaking the risk; in which case he would be guided by some such considerations as the following:—Pulmonary consumption may prove fatal after several attacks, and in any one of a long series of years, and the chances against an attack of the disease falling in any particular year are considerable; and even should it occur in the year covered by the assurance, there is the favourable chance of its commencing at a late period of the year, and either not proving fatal within the year, or (as the disease in its fatal attack has an average duration of nearly two years) not having a fatal issue till long after the period covered by the policy has run out. There is also the further chance that the attack is one from which the patient will recover. Similar reasonings apply to other severe diseases, and, with little modification, to the assurance of all unsound lives. On this branch of the subject, too, it is not possible to lay down any precise rules. To form a right decision large professional knowledge must be combined with sound judgment.

In the case of applicants with a consumptive history, and especially in that of young adults, an arrangement by which the whole premium would be paid in ten, or even in seven years, is to be greatly commended.

There are many questions bearing on the acceptance or rejection of applicants for life assurance, which can be fully discussed only in books wholly devoted to that subject,* or in such learned works as Walford's 'Insurance Cyclopædia.' But some points of practical importance may be noticed with advantage in such brief summaries as those which follow, in which some leading facts and numerical details are set forth under distinct heads.

Pulmonary Consumption.—A disease apt to be concealed under such words as asthma, bronchitis, pneumonia, frequent colds, and habitual cough; and, as a cause of death, under "death in childbed." *Fistula in ano* justifies a suspicion of it, and a small, quick, frequent pulse, spitting of blood, and unusual liability to

* Such as Brinton's 'Medical Selection of Lives for Assurance,' or Sieveking's 'Medical Adviser in Life Assurance.'

attacks of cold, indigestion, and diarrhœa, are among its most common antecedents. It is an hereditary malady, more so in females than in males, and variously estimated as showing itself in from 25 to 60 per cent. of descendants and near relatives. The class of tubercular diseases to which it belongs, causes little less than one-seventh of all the deaths in England and Wales, of both sexes and all ages, and consumption itself nearly one-ninth. In England, females of all ages are somewhat more liable to consumption than males; but, after 15, somewhat less so, and they die earlier. In London they are less liable to consumption than males:—at all ages in the ratio of 98 to 117; above 15, in that of 162 to 213; above 20, in that of 157 to 211; and they attain their maximum mortality later.

Cancer.—Females are more liable to this disease than males in the ratio of 222 to 117; and they attain their maximum mortality earlier. The hereditary tendency to cancer has been variously estimated at from 20 to 30 per cent.

Gout.—The mortality from this disease is small in men, and still smaller in women. The hereditary tendency is estimated at 50 per cent.

Acute Rheumatism.—The liability to this disease is nearly equal in the two sexes, and the maximum mortality occurs in both in the decade ending at 25. It is not the direct cause of many deaths, but is apt to recur; and it lays the foundation of heart disease. Its hereditary tendency has been estimated at 30 per cent.

Heart Disease.—Females are somewhat more liable to heart disease than males, the increased liability showing itself chiefly after 50 years of age. Diseases of the heart (aneurism excluded) occasion about 1 in 20 of the deaths in England at all ages.

Asthma.—There are more fatal cases of asthma in men than in women. It causes 1 per cent. of the total deaths of males aged 35 to 45, and the maximum mortality is attained in the decade ending at 65 years of age. It is never so high as $2\frac{1}{2}$ per cent.

Bronchitis.—This disease is somewhat more fatal to females than to males, and occasions 9 per cent. of the mortality at all ages. The death-rate from this disease, which is nearly 8 per cent. under 15, but only 1 per cent. in the interval from 15 to 25, increases in the following decades as the numbers 2, 5, 10, 17, and 16.

Insanity.—This causes a somewhat higher mortality in women than in men; but in both sexes a small portion (less than a half per cent. of the total mortality. The highest proportion of

deaths (0·41 in men, and 0·55 in women) occurs in the decade ending at 65. Its hereditary force has been variously estimated as 16 and 57 per cent., and it is believed to be much greater in the higher than in the lower classes.

Nervous Disorders.—These cause a somewhat higher mortality in males than in females, and about one-eighth of the entire mortality at all ages. Apoplexy and paralysis are the special causes of most interest in reference to life assurance.

Apoplexy.—This disease is more fatal to females than to males in the proportion of about 24 to 21. The death-rate, which is about 1 per cent. for the decade ending at 25, increases as the figures $1\frac{1}{2}$, $2\frac{1}{2}$, 4, $5\frac{1}{2}$, and 5 in the succeeding decades, the greatest mortality being in the 10 years ending 65.

Paralysis.—The death-rate for this cause is also somewhat higher (24 to 22) in females than in males, but the excess shows itself chiefly after 60. The mortality, which is insignificant for the ten years ending 25, increases for the succeeding decades as the figures 1, 3, $3\frac{1}{2}$, 5, and 7.*

On the purely legal bearings of the subject of life assurance little need be said. It is obvious that the contract entered into in a policy of insurance may be rendered void by any intentional concealment or omission of such particulars of the previous health or habits of the applicant as, if known, must have caused the life to be rejected, or accepted only on more onerous terms; also by omitting to name the medical men who have attended him in any serious illnesses. But even where there has been no fraudulent concealment, questions have been raised as to the tendency of particular diseases, such as indigestion, gout, or mental unsoundness; of accidental injuries, such as fractures, and of particular habits, such as smoking and opium-eating, to shorten life. On all such questions there is much room for difference of opinion among even well-informed medical men.

The definite questions now commonly prepared for the guidance of the medical examiner, and the experience of the insurance offices of the difficulty of obtaining a verdict in their favour, except in cases of undoubted fraud, tend greatly to limit the number of actions at law, and to deprive this subject of some legal interest which it formerly possessed. But its importance in every other point of view, and the value of the services of the medical examiner and referee, are increasing with the growing

* The figures in the foregoing statements are the ratios borne by deaths from the several diseases at the several ages to the total deaths at those ages from all causes. The figures themselves are contained in the table at p. 144 of the 24th Annual Report of the Registrar General for the year 1871.

appreciation of the value of the assurance of life and health, and the consequent extension of the practice of insurance.*

FEIGNED DISEASES.

Diseases and disabilities are feigned, and mutilations self-inflicted, from a great variety of motives: the soldier or sailor to escape from duty, or to obtain his discharge; the mendicant to avoid labour, obtain parochial relief, or impose on private benevolence; the prisoner to escape labour, gain access to the infirmary, obtain his discharge, escape punishment, or occasion trouble; and an accused person to move the court to compassion, and so obtain a mitigation of sentence. They are also assumed with a view of defrauding benefit societies; procuring the comforts of an hospital; obtaining compensation for some pretended injury; and there are persons, particularly young unmarried females, who, without hope of gain, feign diseases in order to excite public interest and curiosity, or private sympathy.

Diseases are most feigned by those who congregate most; as soldiers, sailors, prisoners, beggars, and boys and girls at school. The best school for feigned diseases is the army; and Foderé, speaking of the time when the conscription was in full force in France, says that malingering "was brought to such perfection, as to render it as difficult to detect a feigned disease, as to cure a real one."

Feigned diseases may be said to be of two kinds:—*Factitious*, or those which the malingerer contrives to produce, and *Fictitious* or those which he alleges that he suffers from. To the first class belong external injuries, defects, and diseases (fractures, dislocations, bruises, wounds, ulcers, superficial inflammation, discharges, tumours, malformations, &c.); to the second class, diseases consisting for the most part of groups of symptoms from which the malingerer pretends to be suffering—of such comparatively simple maladies as spasms, convulsions, and palsies, neuralgia and rheumatism, defects of the senses, and loss of sensation, or such complicated maladies as fever, consumption, and epilepsy. For the production of factitious injuries, defects, and diseases, the malingerer resorts to many devices—to force (as when prisoners place their limbs under machines or locomotives); to injection of air, ligatures, and pressure, to pads and the swallowing of effervescing mixtures, to occasion various forms of tumour; to the use of

* On the medico-legal aspects of Life Assurance, see Dr. Sieveking's 8th chapter; also 'Treatise upon the Law of Life Assurance,' by C. J. Bunyon M.A., and Walford's 'Insurance Cyclopædia,' passim.

various irritating substances to create and maintain sores and diseases of the eye; to colouring matters to imitate bruises; to the viscera of animals, and sponge dipped in colouring matter, to counterfeit various forms of prolapsus and malignant maladies; to soap-pills for the production of diarrhœa; to puncture of gum for discharges of blood, and so on.

The malingerer, when he pretends to be suffering from diseases characterized by groups of symptoms, relies in part on simple assertion, in part on the imitation of such symptoms, as are obvious to the senses, in respect of which he resorts to the several expedients just specified. The symptoms which depend upon his own description or simple allegation, such as blindness or deafness, neuralgia or rheumatism, are often asserted with wonderful perseverance and obstinacy, and in spite of proceedings eminently calculated to deter and weary him.

In former editions of this work this subject, in both its aspects of malingering and detection, was treated in considerable detail. But though it may sometimes happen that the services of the medical man are required in police court or at sessions to examine a malingerer under trial, assuming a condition, such as palsy, calculated to move the court to pity, the duty of dealing with malingerers and their pretences devolves chiefly on medical officers of the army and navy, and prison officials, who may be expected to seek instruction from treatises written specially on this subject. In this work, therefore, we content ourselves with suggesting certain rules for the examination of malingerers, with such observations as naturally suggest themselves in connection with them. We may add that several feigned diseases and conditions will be found discussed in other parts of this work, under the head of pregnancy, abortion, unsoundness of mind, wounds, and poisons.

RULES FOR THE DETECTION OF FEIGNED AND FACTITIOUS DISEASES.

1. Inquire after motives for deception. Will the suspected person, by imposition, gain anything he desires, or escape anything he dreads? It should, however, be borne in mind that both men and women feign diseases from other motives than those of gain or personal advantage; and that there may be so complete an absence of all discoverable motive, as to force us to believe in the existence of a moral insanity displaying itself in this way.

2. Inquire into the previous history of the patient, and the

character he bears among his comrades or companions; and whether he has been previously noted for dishonesty and deception. But let it not be forgotten that men who have for years borne the best characters, and conducted themselves with propriety, have been convicted of malingering.

3. When the assumed disease is external and obvious to the senses, make a minute and careful examination both by eye and hand. When there is a suspicion of the use of some irritating substance, inspect the part narrowly with the lens, search the pockets, boxes, or bed of the suspected party, and, if necessary, isolate him so as to deprive him of the assistance of others, and of his means of deception. Examine substances alleged to have been discharged, if necessary by the microscope or by chemical tests. In cases of rigidity, anchylosis, or deformity, place the suspected person under the influence of opium or chloroform.

4. When some defect, or disability not obvious to the senses, but depending on the assertion of the person himself, as pain, blindness, deafness, &c., is supposed to be assumed, try to take him by surprise. Assumed deafness, for instance, should be tested by sudden noises, speaking sharply to the suspected person on his being roused from sleep, or when his self-control has been impaired by opium or chloroform.

5. In cases of feigned diseases, properly so called, we must inquire minutely into the history and alleged causes, and compare the symptoms present with the best descriptions of the real disease.

6. The suspected person should be visited at times when he does not expect to be seen; be watched by those whom he is not likely to suspect; and be misled into the assumption of symptoms foreign to the malady he is simulating. By concealing his suspicions, and foretelling the advent of symptoms which do not belong to the assumed disease, the medical man may lead the malingerer to betray himself.

7. Ascertain whether the suspected person makes use of the medicines and measures prescribed for his relief.

8. In the treatment of suspicious cases, no measures ought to be employed which would not be justifiable if the disease were real. But when there is strong ground for suspicion, low diet, isolation, and nauseous medicines may be resorted to. When the disease supposed to be assumed is not dangerous (*e.g.*, spasmodic twitchings of the muscles), it should be treated with indifference, and as not requiring medical treatment. Persons wantonly abstaining from food generally desist if allusion is made, in their hearing, to cases of prolonged abstinence, and if the alternative of savoury food or the stomach-pump is submitted; and refusal

to take exercise may be met by striking off the best meal of the day, as unnecessary in such cases. Impostors may be caused to desist by treating their several symptoms in detail. A convict professed excruciating headache, offensive discharge from the ear, palsy of an arm, and weakness of the legs. The pain in the head was met by the quiet of a solitary cell; a fragment of blotting paper was placed in the ear, which was covered with adhesive plaster, so that the nature of the discharge might be ascertained. The dropped hand was supported by a splint, and the extensor muscles strengthened by sharp electric shocks. His diet was proportioned to the exercise he could contrive to take. Under this treatment he improved daily. There was no offensive discharge from the ear. In three weeks he was strong enough to attempt an escape from prison, in which attempt he displayed great strength and activity.

Closely connected with this subject is that of disqualifying diseases. It is chiefly interesting to military and naval surgeons; but the services of the medical man are occasionally required in civil cases.

Under this head of disqualifying diseases or defects, one of considerable importance especially to railway managers has been lately brought into prominence; namely, *colour-blindness.* For issues of the gravest importance may depend on the ability of a railway official to interpret colour signals correctly. This defect is more common among males than females. The percentage of colour-blind males is variously stated at from 2·87 per cent. (Fontenoy) to 6·6 per cent. (Donders). There are two kinds of colour-blindness—red-green, and blue-yellow; of which the former is more common and also more important, as red and green are the colours employed for signals on railways and at sea.

The method of testing most relied on is that recommended by Holmgren, of Upsala. Skeins of coloured wool are placed before the individual, and he is required to match those of the same colour.

First he is asked to match a light green skein from a number of coloured skeins placed before him. If he does so correctly his colour sense is normal.

If not correct, a purple skein is given him and he is required to match this. If he matches it with blue or violet, as well as purple, he is red-blind; if with green or grey, he is green-blind; if with red or orange, he is blue-blind. Further, he may be given a red skein and asked to match it. If red-blind he will match it with green and brown shades darker than the pattern; if green

blind, he will match it with green and brown shades brighter than the pattern.*

A medical examiner may also be directed to ascertain whether a person is fit to serve on a jury, or to attend as a witness; whether he is competent to take on him certain offices or duties; or whether he can bear hard labour, or other severe punishment. He may also have to ascertain the state of health of children presenting themselves for admission into public schools. In this case, as in that of recruits, and of persons desirous of insuring their lives, attempts are made to represent the health as better than it really is, and to conceal defects and diseases actually existing.

The subject of disqualification in civil and criminal cases scarcely requires, or admits of, any precise rules; and disqualification for military service is treated in works which the military surgeon is required to possess. The foregoing observations on feigned and factitious maladies apply to *malingerers* in the army and *skulkers* in the navy no less than to impostors in civil life.

* See Examination for Colour Blindness, by Prof. Swanzy: 'Brit. Med. Journ.' October 4, 1879.

CHAPTER V.

UNSOUNDNESS OF MIND.

THIS is a subject on which medical men are often required to give evidence. A man makes a will; its validity is disputed: was the testator, when he made it, in full possession of his faculties? Another squanders his property, or is accused of so doing: is he competent to manage his affairs? A third contracts an unsuitable marriage: could he give a valid consent to the contract? A criminal, or person under accusation, makes a confession: was his mind sound at the time? An act of great atrocity is committed: was the perpetrator responsible for his act? A criminal is supposed to feign insanity that he may escape punishment: is he really of unsound mind? That these questions are of frequent occurrence may be inferred from the fact that the number of persons known to be of unsound mind in England and Wales, and returned as "Lunatics, Idiots, &c.," exceeded 62,000 on the 1st of January, 1874, when it was increasing at the rate of about 1000 a year. Compared with the population at the same date these figures for 1874 yield the proportion of 2·62 per 1000—a number greatly in excess of 1 in 500.

The medical man may be summoned to give evidence in any of our courts of law; civil, criminal, or ecclesiastical: before commissions technically designated *de lunatico inquirendo;* and, in the case of pauper lunatics, before a magistrate. He may also be called upon to sign certificates of unsoundness, at the instance of private persons, with a view to provide for the safe custody and proper treatment of those in whom they are interested.

All inquiries into the state of the mind are surrounded by peculiar difficulties—difficulties inherent in the subject itself, or created by the requirements of the law, and by public feeling and prejudice. The difficulties of the first order arise out of the original individual character of the mind, the degree in which it may have been developed by instruction and education, and the guidance and restraint to which it may have been subjected. Other difficulties inherent in the subject take their rise in the purely inferential character of our knowledge of the mind, in the

inapplicability to it of the method of experiment, in the want of any recognised standard of sanity, and the consequent necessity of erecting our own mental experience into a standard for the minds of others. Minds thus differing in original power, and in acquired knowledge and habits, are variously affected by the same physical and moral causes, and subject to many distinct forms of disease, displaying themselves in language and acts the most varied. Some part of the difficulty that surrounds this subject is also to be traced to the undue importance formerly given, in metaphysical treatises, to the higher faculties of the mind. Reason and imagination were put so prominently forward, and the emotions and passions made to play so subordinate a part, that soundness and unsoundness of mind came to be regarded as almost synonymous with a sound or erring reason; imagination had to bear all the blame of misleading the judgment; and delusion became the favourite and sole test of insanity.

A more simple and practical theory of the mind, recognising several distinct faculties (not reason and imagination only, but emotions and passions also), has now taken the place of these narrow speculations. Separate faculties, originally of different power in different persons, more or less improved by instruction and education, under greater or less restraint from without or within, subject to different degrees of excitement from causes acting within the body or external to it, uniting to form one mind, is the theory that agrees best with reason and experience, offers the readiest explanation of the infinite variety of character, the endless diversities of opinion, and the strange eccentricities of conduct prevailing among mankind. It is also most in harmony with what we know of the unsound mind.

The second class of difficulties, or those due to legal requirements, originate in part from the lawyer's inexperience of the unsound mind, the narrow views handed down to him, and the selection of tests impossible of application: also in part from his looking at the whole question, mainly as it affects individual liberty, or the safety of the State.

The difficulties of the third class, or those that arise out of the state of public feeling, are partly political and partly religious—political, inasmuch as the views expressed with respect to persons of unsound mind are regarded, not as they are true or false, but as they are thought to affect the safety and well-being of society; religious, because being deeply impressed with the fallen and sinful nature of man, the most estimable persons are ever ready to trace strange thoughts and revolting acts rather to that original faint than to disease.

We must premise that it is not possible to frame a single definition of the unsound mind, or to present a just view of it in one description; for mental unsoundness assumes many shapes, necessitating many divisions and sub-divisions, with a corresponding nomenclature. In framing these we shall adopt, as far as practicable, the divisions and names sanctioned by legal usage. Where the law defines with precision the meaning of terms, those terms will be preferred; but where it has failed to do so, those will be employed which have been accepted by the best medical authorities.

In the search after appropriate terms, we first encounter the words "mad" and "insane," applied to the person affected: "madness" and "insanity," to the state of the sufferer. These terms might be at once adopted if they were commonly used as the exact opposites of the words "sane" and "sanity." But as they are generally employed in a restricted sense, and apply chiefly to such deviations from the healthy state of the mind as consist in excessive activity, and rarely, if ever, to those characterized by deficient energy, original or acquired, we must seek for terms to which we may attach a more precise meaning. Such are "Unsoundness of mind" applied to the condition of the mind itself, and "Non compos mentis" to the person whose mind is affected.

But of these terms, the first—"Unsoundness of mind" is not free from objection; for in the Portsmouth case Lord Eldon spoke of it as requiring to be distinguished, both from idiocy and lunacy; and in many statutes it is found associated with the words Idiot and Lunatic; and Lord Chief Justice Cockburn* takes the authors of the New Criminal Code to task for including imbecility under insanity. Unsoundness of mind, then, is better than any other phrase in common use, and is placed at the head of this chapter. But, "Non compos mentis," applied to persons of unsound mind, having been more consistently used by legal authorities, is to be preferred to all others.

We must next inquire what the law includes under this term, *non compos mentis*, what forms of unsoundness it recognises, and how far it consists with our knowledge as medical men to adopt a classification in accordance with it.

The common law of England originally included under this term only two forms, Idiocy and Lunacy, but the highest legal authorities long since saw the necessity of more minute subdivision. Thus Lord Coke recognised four sorts of *non compos mentis*:—"1. *Idiota*, which from his nativity by a perpetual

* Letter on the Criminal Code (Indictable) Offences Bill, 16 June, 1879, p. 14.

infirmity is *non compos mentis*. 2. He that by sickness, grief, or other accident wholly loseth his memory and understanding. 3. A lunatic that hath sometimes his understanding, and sometimes not, *aliquando gaudet lucidis intervallis*, and therefore he is called *non compos mentis* so long as he hath not understanding. Lastly, he that by his own vicious act for a time depriveth himself of his memory and understanding, as he that is drunken."

Here we have distinctly recognised the three forms, *Idiocy*, *Dementia*, and *Lunacy*; of which the first two are well defined and admit of being used both by lawyers and doctors in the work of classification. The term *Lunacy* is objectionable, as implying only that form of mania which is characterized by lucid intervals.

Lord Hale, by recognising a distinction between general, or total, and partial unsoundness, justifies the separation of monomania from mania. We have good legal authority, therefore, for four forms of unsoundness—Idiocy, Dementia, Mania, and Monomania.

These four states, taken as varieties recognised by the law, may be expanded into a reasonable and useful classification by adding the forms or phases of unsoundness recognised by the best medical authorities. Idiocy, Imbecility,* and Cretinism, may be made to fall under the one heading, *Amentia*; *Dementia* to comprise the acute and chronic, or primary and secondary, forms of mental degeneracy, as well as the state known as General Paralysis; and *Mania*, not affections of the intellect only, but those also of the emotions, recognising in both a general and a partial unsoundness.

These distinctions are embodied in the following tabular arrangement, which presents the leading forms of unsoundness at one view, and will serve as a convenient index to the order in which this subject will be treated.

Amentia.	*Dementia.*	*Mania.*
1. Idiocy. 2. Imbecility. 3. Cretinism.	1. Acute, or primary. 2. Chronic, or secondary. 3. Senile Dementia. 4. General Paralysis of the insane.	1. General (*Raving Incoherence*). 2. Intellectual. { General. / Partial. { Monomania. / Melancholia. }} 3. Moral . . { General. { Complete loss of self-control. } / Partial. { Homicidal. / Suicidal, &c. }}

* Cockburn, C. J., in the letter just cited, calls an "imperfect condition of mental power," "*Imbecility*," whether it arise from "congenital defect" or "natural decay," and so confounds Amentia with Dementia.

This, like all other attempts to frame a reasonable classification of a subject so difficult, is by no means free from objection. Cretinism, for instance, comprises both Idiocy and Imbecility, but with corporeal defects and malformations so peculiar as to require separate notice, Senile Dementia and the General Paralysis of the Insane, though alike involving mental decay, also demand a separate recognition; while the many forms of Mania are but imperfectly set forth in the table. Perhaps the most philosophical classification that could be proposed would be based on the recognition of the leading forms:—the *undeveloped*, the *degenerate*, and the *disordered* mind—Amentia, Dementia, and Mania.

As unsoundness of mind is a large subject, embracing many details, a methodical arrangement of it is absolutely necessary. It will accordingly be treated under the following heads:—1. Of certain states of mind compatible with sanity, but illustrative of unsoundness—viz., illusions, dreams, and somnambulism. 2. Of certain states allied to unsoundness, and caused by disease, or the action of poisons—viz., delirium, delirium tremens, and drunkenness. 3. Of the several forms of unsound mind treated in the order in which they stand in the foregoing table. 4. Of the more important characters of the unsound mind, and of its medical and legal tests. 5. Of feigned unsoundness of mind. 6. Rules for the examination of persons deemed to be of unsound mind, and for the guidance of the medical witness in these cases.

I. ILLUSIONS, DREAMS, AND SOMNAMBULISM.

These phenomena have a close connexion with, and direct bearing on, mental unsoundness. Spectral and other illusions are common in the insane; dreams are generally recognised as analogues of insanity, and the acts of the somnambulist may give rise to medico-legal questions.

Illusions.—A sensation without corresponding external object is called an *illusion.* When it is due to an act of the will, it is known as a *vivid perception.* When the eye is, or seems to be, the seat of the sensation, it is called a *spectral illusion, phantom,* or *phantasm.* In the well-known case of Buranelli, the medical witnesses were examined as to the proper meaning of the words *illusion* and *delusion.* There ought to have been no difficulty in defining them. The difference is best shown by adding three words to each:—an illusion of the senses, a delusion of the mind. An illusion means a mockery, false show, or counterfeit appearance; a delusion, a chimerical thought. It may be well

to add that an illusion of the senses, if believed to be a reality, becomes a delusion of the mind. The word illusion may be applied, with equal propriety, to a sensation without corresponding object, to a transformed appearance of a real object, or to an internal sensation exaggerated or misinterpreted. It is improperly applied to real sensations, such as the enlarged shadows projected on to masses of clouds, misinterpreted for a time through ignorance and superstition into the "Giant of the Brocken," real sailing ships, and real fighting armies. Some authors who wish to distinguish illusions, pure and simple, from what we prefer to call "illusive transformations," make use of the term *hallucination*. Brierre de Boismont, for instance, uses this term to designate an unreal sensation wholly due to the action of the brain; and *illusion* to designate a real sensation exaggerated or distorted by the same operation; and Griesinger, quoting Esquirol with approval, sanctions substantially the same distinction. This word *hallucination* has indeed the same meaning with the French as our word illusion; but as old English authors used it in the sense of an error, mistake, or blunder, and medical writers sometimes of an illusion, sometimes of a delusion, it ought to be allowed to fall into disuse. But, whatever terms we elect to use—these four distinct conditions ought not to be confounded one with another:—A voluntary representation of an idea on an organ of sense, which is a vivid conception; a sensation, without corresponding external object, which is an illusion; an involuntary transformation of a real object, which is also an illusion, and would be correctly designated "an illusive transformation;" and anything actually seen, such as a mirage, misunderstood and misinterpreted.

Illusions may occur as early as four years of age; in young and middle-aged adults; and in octogenarians in either sex, but much more frequently in males than in females. Some who have experienced them have been distinguished by active memories, extreme sensitiveness, and great ability: others by none of these. Some were in perfect health at the time, some suffering from trivial and transient indispositions, curable by such remedies as moderate depletion and simple aperients, others in the first onset of more serious diseases, inflammatory and febrile, or during convalescence; and others again in states of exhaustion, and especially in the condition of mind and body brought on by the exposures and privations of shipwreck.

Illusions have also been produced by every form of arrested and disordered cerebral circulation, by the inhalation of the fumes of burning charcoal, and by carbonic acid generated by over-

crowding, also by many poisons of the narcotic and narcotico-acrid class; and notably by opium, alcohol, Indian hemp, belladonna, hyoscyamus, and stramonium.

Illusions of sight (spectral illusions) are the most common; those of hearing come next in order; those of taste, smell, and touch are more rare.

Spectral illusions have been most studied, and in them there are differences interesting to physiology, but of little practical importance.* But these two facts admit of practical application; —1. That these illusions occur in the irremediably blind,† and that, in these cases, they must result from changes in the cerebral circulation, or in the brain-tissue. 2. That though, in some cases, they follow directly on an excited emotion, such as anxiety or fear, and might, therefore, be attributed to the imagination responding to it, in the greater number of cases they are as involuntary and as independent of the fancy as spasms or convulsions.‡

Now spectral and other illusions are very common in some forms of unsoundness, and serve to explain, in part, the obstinate belief by which the mind is possessed. Thus a religious maniac, the author of a most interesting autobiography,§ strongly confirmed by statements made to me by persons similarly afflicted, says, in reference to his many spectral illusions: "I imagined I was really present to *them;* and that my not acknowledging it was a delusion, an obstinate resistance of the Divine will on my part. That of the two, the appearance of the bed, walls, and furniture was false, *not* my preternatural impressions." This statement is fully borne out by the details in which this instructive work abounds (G.).

Spectral illusions, then, may occur in persons of sound and of unsound mind, the difference being, that the former do not believe in their reality, the latter do. The sane man corrects these false impressions by appealing to his other senses, or to the sensations of other persons;‖ while the man of unsound mind neglects these simple means of undeceiving himself, or cannot use them; or, if he have any doubt, dispels it by the help of his delusion. Thus,

* For cases in detail see the works of Alderson, Hibbert, and Ferrier, Sir David Brewster's 'Letters on Natural Magic,' Sir Walter Scott's 'Demonology and Witchcraft,' and Brierre de Boismont 'On Hallucinations.'

† See Sir Benjamin Brodie's 'Psychological Inquiries,' p. 85, for a case of delirium with illusions in a man who became blind after an injury to the head.

‡ There is also good reason to believe that animals under the influence of certain poisons are subject to illusions.

§ 'A Narrative of the Treatment experienced by a Gentleman during a state of Mental Derangement,' p. 63.

‖ A blind gentleman, who saw carts and carriages as he walked the streets recognised them as illusions of his brain by observing that their movements were not attended by the usual sounds (G.).

the author of the autobiography thought it *impious* to doubt.

It is the absence of those simple objects and standards of comparison, which are present in the day-time, that gives to nocturnal illusions so much reality. This difference was pointed out by Dr. Alderson, of Hull, who lays claim in his work on 'Apparitions' (and with apparent justice) to have been the first to explain the phenomena of spectral illusions.

Dreams.—The phenomena of dreaming have a striking analogy to those of some forms of unsound mind. The external world being shut out, and the higher faculties inactive, illusions and delusions have the vivid impress of reality, and follow each other according to associations over which we have no control. Many dreams are directly traceable to states of body which, when we are awake, produce pain or uneasiness, such as fulness of stomach, distension of bladder, or irritation of skin. The sleeper is conscious of this uneasy sensation, and seems to be seeking relief in unlikely ways and places, or he associates it with imaginary events. Thus a fit of indigestion is converted into *a nightmare*, and the ruffled dressing of a blister on the head suggests a dream of being scalped by savages. In other instances the uneasy sensation gives rise to a dream which has no other relation to the sensation itself than that of being painful or disagreeable; or it induces a state of mind in which disconnected occurrences, recent or remote, having nothing in common but the feeling of annoyance or discomfort, are blended together. We hear of a distressing accident; we receive bad news of an absent friend; and we have been concerned in some anxious business: a dream combines these scattered elements; we are ourselves connected with the accident; the absent friend is in our company; and the person with whom the business is transacted also appears on the scene.

Dreams excited by certain sensations are subject to a strange law; a sound which wakes the sleeper occasions a dream that seems to have occupied a considerable time. Thus, "a gentleman dreamed that he had enlisted as a soldier, joined his regiment, deserted, was apprehended, carried back, tried, condemned to be shot, and at last led out for execution. After all the usual preparations a gun was fired; he awoke with the report, and found that a noise in an adjoining room had both produced the dream and awakened him."*

* The reader is referred to Dr. Abercrombie's well-known work, 'Inquiries concerning the Intellectual Powers, and the Investigation of Truth,' for many instructive facts relating to this subject; and for further information on he physiology of the human mind, to the chapter on Mental Physiology and Pathology in Hooper's 'Physician's Vade Mecum.'

Blows on the head also occasion dreams, which appear to assume one of two forms. Either the immediate antecedent of the blow seems to occupy a long time, or some sensation accompanying it is indelibly impressed on the memory. The superintendent of a lunatic asylum, as he was kneeling in chapel, received a blow on the head from a stone enclosed in a handkerchief. The man who dealt the blow rushed at him suddenly, screaming. The wounded man fell on the ground bleeding and insensible, and on recovering his senses, had no other recollection of what had taken place than that his assailant seemed to have come to him from a long distance, and during a long space of time. This is a good example of the first class (G.). A striking illustration of the second class is afforded by a case tried at Cambridge before Mr. Baron Bramwell, March, 1868. James Williams took one Robert Lowe into his cart, which arrived safe at home, but the owner was found huddled up in a corner of it, insensible and covered with blood that had flowed from a number of severe incised wounds on the left side of the head. He was for some time in great danger, and slowly recovered consciousness; but his mind continued to be a perfect blank as to the assault, and the circumstances that had preceded it. He had no recollection of the prisoner or any one else riding in the cart with him. He stated, however, that he had constantly before his eyes, day and night, and could not rid himself of it, the impression of a certain cap and of a jacket, with buttons upon it unlike in size, shape, colour, and position. When brought in contact with the prisoner, and told to examine the jacket, he said, "I don't want to look at it twice. I can see every button of it, and every shape of it every day. If they were to put that dress among a hundred, I should pick it." Lowe was convicted, and sentenced to penal servitude for life.

The strong analogy that exists between dreams and certain forms of unsound mind, is shown in the example cited at p. 212, and the passing of the one into the other, by the case of a maniac, who for a week after his recovery was harassed in his dreams by the same rapid and tumultuous thoughts, and violent passions, which had agitated him when insane (Dr. Gregory).

The case of M'Naughten may be cited as bearing a close resemblance to one class of dreams. His father's refusal to take him into partnership originated in him a sense of hardship and injury: the Roman Catholics, the Police, and the Tories, being the successive themes of newspaper abuse, and being also represented as guilty of acts of injustice, impressed his mind with the same feeling. Hence the long dream of years, in which the

sense of public injury was transferred to himself, as the fancied object of political persecution.

The difference between dreaming and insanity is, that in the one, the senses are closed to outward objects; in the other, the evidence of the senses is disregarded, or they suggest trains of wild and fanciful association, illusions blended with objects rightly perceived being misinterpreted by the prevailing delusion. As soon as the dreamer is roused from sleep, and the outer world is again before him, all illusions and delusions vanish; but the mad man is in a waking dream, from which he cannot be roused.

Legal relations of Dreaming.—A question of criminal responsibility arises in those rare cases in which a man suddenly roused from sleep kills another. Such was the case of Bernard Schedmaizig, who suddenly waking at midnight thought he saw a frightful phantom, which giving no answer to his challenge twice repeated, and seeming to advance upon him, he attacked it with a hatchet that lay beside him. He had killed his wife. Ray also relates the case of two men, who being out at night in a place infested with robbers, engaged that one should watch while the other slept; but the former falling asleep, and dreaming that he was pursued, shot his companion through the heart. Again, there is the case of the pedlar, who being rudely roused from sleep by a passer-by, ran him through the body with the blade of a sword-stick; and was found guilty.* If these cases are rightly reported, it is difficult to understand how the homicidal act should be deemed criminal. It will be observed that, in the case of Schedmaizig, the immediate motive to the homicidal act was an "illusive transformation" of his wife into a "frightful phantom."

Somnambulism.—This is a form of dreaming in which the senses and voluntary muscles have full play; the one exercised with extraordinary acuteness on the subject-matter of the dream, the other obeying the mandates of the sleeper's will with unwonted precision. The mind during the dream is so concentrated on one subject, that the reason or fancy will accomplish tasks to which it is unequal during the waking hours; and this concentration probably accounts for that extraordinary acuteness of the senses, that precision of movement, and that total absence of fear which marks such acts as walking on the edge of a precipice, swimming a rapid stream, or riding at full gallop. Som

* These cases are quoted by Dr. Forbes Winslow in his 'Plea of Insanit in Criminal Cases,' the first from Dr. Pagan, the last from the 'British an Foreign Medical Review.'

sleep-walkers, at each recurrence of the fit, perform some routine duty with all the precision of their waking hours.

In some cases, so complete is the mind's abstraction, that the loudest noises are unheeded; in others, those things only are attended to which harmonize with the existing train of thought. After the fit, there is either complete unconsciousness of what has occurred, or it is remembered as an ordinary dream. In some cases, that which has transpired in one fit is distinctly remembered in subsequent ones, but quite forgotten in the intervals.

The analogy just pointed out between dreaming and insanity extends to some cases of somnambulism; for in some somnambulists, as in some madmen, there is a remarkable increase of talent, in others a complete change of character; in other words, there may be an intellectual and moral somnambulism, as there is an intellectual and moral insanity. The following cases support this view. A Carthusian monk, remarkable for simplicity, candour, and probity, walked almost every night in his sleep, a thief, and a plunderer of the dead. A pious clergyman, in his fits of somnambulism, would steal and secrete whatever he could lay his hands upon, and even plunder his own church. A suicidal somnambulist had fits every night, and required to be watched, as if suffering from an acute disease. He always tried to escape; and one night having succeeded, was found hanging by the feet from a high tree.* Homicidal somnambulism is illustrated by the following case. Late one evening a monk entered the room of the prior of the convent, his eyes opened and fixed, a frown on his features, and a knife in his hand. He walked straight up to the bed, as if to ascertain if the prior were there, and then gave the bed three stabs. This done, he returned with his features relaxed, and wearing an air of satisfaction. Next day, being questioned, he confessed, that having dreamed that the prior had murdered his mother, and that her spirit had appeared to him, and cried for vengeance, he was transported with fury, and ran directly to stab her assassin. Shortly after he awoke, covered with perspiration, rejoiced to find that it was only a dream.†

Legal relations of Somnambulism.—A question has been raised as to the responsibility of the somnambulist for acts committed during the fit, on the ground that what is done in the fit being often only the accomplishment of a project formed while

* 'A Treatise on the Medical Jurisprudence of Insanity.' By J. Ray, M.D.
† Quoted from an anonymous work, 'Des Maladies Mentales,' by Georget.

awake, he ought to be held responsible. This is a gratuitous assumption, that cannot be seriously entertained till some fact shall have been advanced in its support. If such a question of responsibility should arise, it ought to be shown that the sleep-walking was not feigned, and that the accused was subject to it.

For some interesting cases of ecstasis, or cataleptic somnambulism, which is nearly allied to hysteria, and almost invariably occurs in females, the reader is referred to Abercrombie on the Intellectual Powers.

II. DELIRIUM, DELIRIUM TREMENS, AND DRUNKENNESS.

Delirium occurs in most severe febrile and inflammatory diseases, especially those which attack the internal viscera; is a common sequence of severe accidents, and surgical operations; and often ushers in the fatal termination of chronic disorders.

Febrile delirium is generally preceded by pain and throbbing in the head, heat of scalp, and flushed face; but it sometimes makes its attack suddenly. In the first class of cases it is often preceded by dreaming. The patient talks in his sleep, and wakes up confused and forgetful; but when fully roused, is collected, and so remains till the next slumber. By degrees this disturbed sleep passes into waking delirium. The patient lies on his back, dull and listless, with eyes half open, muttering to himself, unconscious of persons or things, and when roused scarcely recognising them. The symptoms grow more marked as the strength fails; the voice becomes less distinct; the fingers are constantly picking at the bed-clothes; the evacuations pass unconsciously; and the patient can no longer be roused to an effort of attention.

If delirium occurs at an earlier stage, before the strength has been much impaired, the symptoms are somewhat modified. The bloodshot eyes are intently fixed as on some object really present; and the patient talks loudly and earnestly, tosses restlessly about, makes repeated attempts to leave his bed, perhaps escapes from the attendants, displays great strength and activity, and may even commit fatal acts of violence.

The delirious patient will sometimes show that he is passing in review the transactions which had engaged his attention before he fell ill, or he will display a painful eagerness to accomplish some object which he then had at heart.

In fatal cases, delirium usually passes into coma, but occasionally it disappears some hours or days before death, leaving the patient in full possession of his faculties.

In some cases the memory of things long past revives, and

languages that had long fallen into disuse are again spoken with fluency.

Delirium is an almost constant symptom of poisoning by belladonna, hyoscyamus, and stramonium; a frequent result of poisoning by other narcotico-acrids; an occasional one in poisoning by the pure narcotics and irritants.

Delirium closely resembles that form of unsound mind known as incoherence, but is distinguished from it by its history. When not caused by poison it is a symptom of some well-marked disease or a result of some severe accident or operation, while incoherence is rarely accompanied by bodily disorder, till it has lasted long enough to become associated with paralysis.

Legal relations of Delirium.—Civil acts performed during an access of delirium are necessarily void, and criminal acts entail no responsibility. The validity of wills made by patients labouring under diseases attended with delirium is usually decided less by the proved existence of a lucid interval, than by the character of the will itself. If in keeping with the testator's known character, and with intentions expressed, or instructions given, when sound in mind and body; if the several parts are consistent with each other; and if no improper influence was brought to bear upon him; the will would be declared valid, even though the medical evidence threw doubts on his capacity. On the other hand, in the absence of these conditions, the will would generally be declared invalid, in spite of the strongest evidence of the testator's capacity.

It is important to distinguish delirium, with intervals of perfect consciousness, from the calmness of demeanour sometimes assumed by patients labouring under strange delusions, showing themselves in the first stage of convalescence from fever or other acute disease; or in delirium tremens brought on by drink. Here, too, the history of the case, and the state of the patient, will have to be carefully considered.

Delirium Tremens.—The delirium of drunkards is easily recognised by the peculiar form which the mental unsoundness assumes, and by the equally characteristic bodily symptoms, aided by the previous history; and, in most cases, by the prompt recovery following the judicious use of remedies.

The patient is restless, sleepless, timid, suspicious, and cunning. He has highly characteristic illusions of hideous and loathsome objects, such as toads, serpents, and scorpions; believes that he is assailed by strange sounds and angry voices; or threatened by thieves or evil spirits. When under treatment he is suspicious of the attendants; is constantly trying to escape; and, if

not properly watched, may do violence to himself or others. Some patients display a painful eagerness to go somewhere, or do something on which their minds are bent. In extreme cases the patient exhibits all the symptoms of acute mania. The bodily symptoms consist of the tremor from which the disease derives its name, with a pale, cold, clammy skin, a moist, white, tremulous tongue, and a small weak pulse. The history of the case is that of a course of intemperance terminated by a short supply of liquor, or by some exhausting disease or surgical injury. Sometimes it follows a single debauch, especially in men who have had previous attacks of mania, or of cerebral inflammation, or who have suffered from severe falls or blows on the head.

In the milder forms of the affection, the patient goes about as usual, answers questions collectedly, and converses rationally; but when left to himself, he is in a waking dream, speaking of things calculated strongly to excite the feelings and passions with perfect freedom from excitement; *e.g.*, asking the porter of the out-patients whether he did not say that he would kill him (G.).

Prolonged abstinence, too close attention to study or business solitary confinement, and sexual excesses or mal-practices, sometimes brings on a state closely allied to delirium tremens, and characterized like it by illusions of sight and hearing.

Legal Relations of Delirium Tremens.—As delirium tremens is a recognised disease, with mental unsoundness as a symptom, the patient cannot be held responsible for his acts. Accordingly, though drunkenness has no effect on civil or criminal acts, delirium tremens has the same effect as insanity itself.

Drunkenness.—The excitement which, in persons of sound mind, attends the indulgence in alcoholic liquors, is converted, in those of unsound mind, into manical incoherence, distinguishable from mania due to other causes only by the history of the case and the evidence of the sense of smell. A craving after spirituous liquors is one of the recognised forms of unsound mind (dipsomania); while in others it is merely a leading symptom of a more general disorder. In some cases the craving after alcoholic liquors shows itself only at intervals.

Legal Relations of Drunkenness.—This has no legal effect. It neither increases nor mitigates the penalties that attach to crime, and it has even been deemed an aggravation. A drunkard's acts are therefore valid, unless it can be shown that the drunkenness was procured by another person to obtain an unfair advantage.

III. OF THE SEVERAL FORMS OF UNSOUND MIND.

These resolve themselves as already stated, into three leading classes, *Amentia*, *Dementia*, and *Mania* (forms of the undeveloped, degenerate, and disordered mind).

AMENTIA.

Of this there are two species, *idiocy* and *imbecility*, as well as the mental defect traceable to local causes and known as *cretinism*.

Idiocy.—The best legal and medical writers agree in describing idiocy as a congenital malady, and the idiot as one " who from his nativity by a perpetual infirmity is *non compos mentis*." But some writers of both professions have used the term with less precision, evidently confounding the idiot with the victim of dementia, or even of mania. The time for such confusion of terms is past, and there is now a clear understanding that idiocy is a congenital absence, or serious defect of, all the mental faculties; but a state admitting of degrees, and, like other forms of unsoundness, not allowing of strict definition.

In its lowest form idiocy combines the extreme of bodily deformity with an existence purely vegetative. Such idiots seem devoid even of sensation, and would perish if not closely attended to. In a somewhat higher form there are sensations of heat and cold, of hunger and thirst, and just intelligence enough to indicate the commonest wants by signs. A still higher class consists of those idiots who have sensation and consciousness, recognise familiar persons and objects, are susceptible of attachment, can move from place to place, are able to make known their wants by gestures and sounds, or even by words imperfectly articulated, can be taught habits of decency, can learn to hum or sing, or even to perform the simpler operations of arithmetic, and are susceptible of some improvement in their bodily and mental condition under careful, assiduous, and skilful teachers.

As a rule, idiots are deformed in body as well as stunted in intellect. They have small, mishapen heads, and features ill-formed and distorted—squinting eyes, large gaping mouths, ill-formed palates, thick lips, irregular teeth, and sallow and unhealthy complexions. The limbs and trunk are also imperfectly developed, and their gait is awkward and unsteady. Some of their senses are wanting and others very imperfect.

Fig. 24 (one of the graphic illustrations of the late Sir Alexander Morison*) shows the head of an idiot of this type, 28 years old, four feet and a half high, with flattened forehead, thick lips, large, gaping, slobbering mouth, and awkward unsteady gait,

* The illustrations which follow are from the same source.

his favourite posture leaning against a door, and beating it gently with his head. His sense of touch is very obtuse; his utterance is limited to the monosyllable *tee, tee;* his temper is good, and he often laughs discordantly. He can feed, but cannot dress or undress, himself; is inattentive to the calls of nature; exhibits no affection; shows no shame; is not moved by music, and is said to be inclined to onanism.

Fig. 24.

The female figure, fig. 25, is 18 years old; has a small flat head, is of short stature, but not deformed; has a vacant expression, and silly laugh; repeats the monosyllable *um, um,* and parrot-like, the words *good day, good night.* She is fond of sweets, and pleased with finery. She puts a watch into her mouth; feeds herself, but cannot dress or undress, and does not heed the calls of nature.

Fig. 25.

The child whose portrait is given in fig. 26 belongs to the exceptional class of idiots who are free from cranial and facial deformity. His age is six. He was born an idiot, but grew worse in his third year, after attacks of measles and whooping-cough. His senses are perfect; he can say a few words, such as *mother,* and *poor boy;* has affection for his parents, takes pleasure

watching his father at work, and exhibits a slight power of imitation; feeds himself, but will eat fish and flesh raw; attends to the calls of nature; is very restless, and keeps up a continual whine.

Fig. 26.

Idiots at the age of puberty often display the sexual passion by offensive gestures and disgusting habits, are subject to violent outbursts of passion, and sometimes commit acts of atrocious cruelty.

The Legal Relations of Idiocy, in the sense here assigned to the term, are obvious. It implies complete civil disability, and irresponsibility.

Imbecility.—This term is here used to designate a mental defect manifesting itself in infancy, as distinguished from that which is congenital.

Idiocy and imbecility ought perhaps to be equally characterized as congenital defects, of which the more marked (idiocy) reveals itself soonest, while imbecility is not recognised till the faculties have been tested by education, and found wanting. It is obvious, too, that no sharp line of distinction can be drawn between the idiot and the imbecile, for the fainter shades of imbecility pass into the lighter tints of idiocy. But the possession by the imbecile of the faculty of speech, as distinguished from the parrot-like utterance of the few words which the idiot can learn, is the best line of demarcation the case allows of.

Most imbeciles are intellectually as well as morally deficient. They have a limited power of acquiring or retaining knowledge, cannot understand or appreciate the customs of society or laws human and divine,* and cannot control their emotions and

* Some of the imbeciles who have committed murder obstinately assert that they had a right to act as they did. This was, in our experience, the case with two men who killed young women, the objects of their attachment, and of a third who murdered a tax-gatherer at Newcastle. This man not only asserted his right, but quoted Scripture, in a confused manner, as his authority (G.).

passions. But there is a small exceptional class which exhibits intellectual deficiency without seriously offending against morality, and a larger one, which combines the highest intellectual endowments with utter incapacity in the conduct of life. There is, therefore, an intellectual, a moral, and a general imbecility, as there is an intellectual, moral, and general mania.

Fig. 27.

The first of the annexed illustrations (fig. 27) represents an imbecile thirty years old and four feet nine inches high, who is described as having a very small head, and a silly expression of countenance. His eye, however, is rather lively, and he possesses more intelligence than we should expect from his appearance; he can talk rationally upon common subjects, makes himself useful, and has worked in servile offices.

Fig. 28.

The subject of the illustration in fig. 28, like the idiot child in fig. 26, is well-formed in face and limb; eighteen years old, and four feet nine inches high. He has good features, and an agreeable, though somewhat vacant expression. He speaks plainly, answers questions rationally, and has been taught to read and write; is

fond of music, for which he shows some talent, and has a good voice, a correct ear, and sings very well. He has been a baker and a waiter at an inn; says that he will always be a good boy, be polite and bow to gentlemen, and will work like anything if work be given him. He feeds, dresses and undresses himself, and is attentive to the calls of nature. He is subject to epileptic fits, and is quarrelsome, tells lies, and indulges in a solitary vice.

Fig. 29.

Fig. 29 is the portrait of a man of forty, of weak intellect from birth, but capable of such education as fitted him for the post of a copying clerk. He fell into bad company, committed theft, but was tried, and acquitted on the ground of insanity. In general he is quiet, inoffensive, and taciturn, but answers simple questions rationally. He is subject to frequent attacks of excitement, preceded by shuffling of the feet. In these attacks, which last several days, he talks incoherently, is restless, and will strike and kick those about him. When he was about thirty he shut the door of his room, placed a long form close to the fire, laid himself on the form, and his head on the grate. He was found insensible, but on being removed to an open window, bled freely from the nose, and soon came to his senses. His head was burnt to the bone.

The form of imbecility which is most common, and most important in a medico-legal point of view, is that which affects the intellect, the morals, and the prudential conduct of life. Persons who exhibit this threefold deficiency profit by education, so as to form and express simple ideas, to read, write, and count, and to become musicians, draughtsmen, or mechanics. They may even attain proficiency in some one branch of knowledge, or some one accomplishment; but they do not profit by the opportunities afforded them in the same degree as their neighbours. They also present great varieties of character. Some are fickle and changeable, and incapable of fixing their attention; others

methodical and persevering. Some are fit only for the coarsest and rudest labours, while others, when duly assisted and guided, are equal to the conduct of business and management of property; for they know the value of money, and can give information on matters with which they are conversant, but are unequal to emergencies, and unable to sustain close conversation or argument. They are thoughtless, improvident, uneasy, and restless, subject to long fits of melancholy, and much given to wandering about, and generally incapable of strong and steady attachment. Among the lower orders of society there are many imbeciles following occupations requiring little sense or skill, and their neighbours look upon them as weak and singular persons, and tease and torment them accordingly; or they become lazy, drunken, and dissipated, and addicted to begging and petty larceny. Some, under slight temptation, and very inadequate motives, break out into fits of ungovernable passion, and commit acts of wanton mischief, arson, rape, or murder. They are much interested in what they read about crimes and criminals, and are prone to imitate them. "They steal adroitly, and hence are considered as very intelligent: they recommence their offences the moment they are released from confinement, and thus are believed to be obstinately perverse." "They have no idea, or a very imperfect one, of society, laws, morality, courts, and trials; and though they may have the idea of property, they have no conception of the consequences of theft. They may have been taught to refrain from injuring others, but they are ignorant of what would be done to them if guilty of incendiarism or murder." "Their conduct is actuated solely by the fear of punishment, when capable of experiencing that sentiment, and by their own desires." Georget, to whose work, 'Sur la Folie,' I am indebted for much of this description, says that "these beings of limited capacity furnish to the courts of justice, to prisons and scaffolds, more subjects than is generally supposed." *

But imbecility, as already pointed out, is not always of this mixed character, displaying itself at the same time in the intellect, morals, and conduct. It is sometimes partial, affecting only, or chiefly, either the intellectual or the moral character. There may be, on the one hand, an inability to acquire and apply knowledge in persons who have a due sense of right, act with integrity, and

* I can confirm this statement by my own experience of convicts, as well as by the numerical results of an inquiry which showed that while imbeciles are remarkable for the long succession of petty offences which they commit, they are guilty of all the graver crimes of arson, murder, rape, and unnatural offences, much more frequently than are an equal number of criminals reputed to be of sound mind (G.).

perform every social duty; and, on the other, an unusual power of acquiring knowledge, with judgment, fancy and refined taste, but combined with feebleness of purpose, want of self-control, inaptitude for business, disregard of duty, and want of common honesty. Such persons are known in society as weak, soft, easy, good-natured, well-meaning, good sort of people, and if possessed of brilliant talents, as having every sense but common sense. They are too easy to be just; too thoughtless to be honest. They have an instinctive horror of business, an aversion to their regular occupations, and a distaste for everything that wears the shape of duty. They are utterly ignorant of the value of money, and the last use they make of it is to pay their debts. Each man among them has his own favourite form of extravagance, and his own mode of ruining himself. One calls an architect to his assistance; another an upholsterer; a third collects useful things which he never uses, or displays a curious taste in worthless trifles; or (worse still) becomes the incorrigible patron of mendicants and mendicant-thieves. These people are always forming acquaintances with unworthy persons, who find it worth their while to know and to flatter them. With all their easiness of disposition they have much warmth of temper and strength of passion. They are bad children, husbands, and fathers, because in these relations they have duties to perform. Throughout life they are weak, wavering, fickle, and self-willed as children; the source of constant anxiety and misery to their families; the prey of designing knaves; the expected inmates of gaols, workhouses, and lunatic asylums.

These moral imbeciles remain at large, because the intellect being unaffected, they have no distinct delusion; and as weakness of intellect is a necessary ingredient in the legal idea of imbecility, the attempt to prove such persons of unsound mind, in a court of law, necessarily fails. That absence of moral sense, and corresponding want of self-control, which is the essence of their mental malady, can be proved only by the history of their daily life; a history often hard to obtain, and generally studiously withheld.

Imbeciles are sometimes as much under the dominion of childish fancies as maniacs are of delusions. A commission of lunacy was granted in the case of a young gentleman, aged 20, the slave of a childish fancy for windmills, with an aversion equally strong to watermills. Having been placed under control in a place where there were no windmills, he cut the calves of a child's legs to the bone, and stated that he should have taken away its life, that he might be tried for the act, and removed from a place where there were no windmills. He had

always been violent when thwarted in his fancy, had threatened his keeper and members of his family, and had more than once made preparations for committing murder. When we chanced to see him in a distant asylum, he was expecting to be appointed head miller to a maniac who alleged, among other strange claims to dignity and importance, that he was king of England (G.).

A typical and most instructive case of this class was tried at Taunton, March, 1868, before Bovill, C. J. A. H. was indicted for the wilful murder of J. W., a boy of 13. The prisoner, æt. 28, was notoriously an imbecile from his childhood, deemed by his father a harmless lunatic, described by the person with whom he was put to live as quiet and well-disposed, of good and peaceable conduct, and by a *medical expert* as of weak intellect, and having "an imperfect development of mind and body," subject to headaches and long fits of melancholy, and, according to his own unconfirmed statement, to fits. He was fond of reading the Bible, and had expressed a wish to be a Scripture-reader. He was greatly addicted to wandering about from place to place. A. H. was fond of gardening, but would sow seeds one day and dig them up the next to see whether they were growing. On the morning of the murder he walked twenty miles, armed with a big stick and a sharp knife. Early in the evening of this day he gave himself up to the police as "having killed a human being," and crying bitterly at the thought of what he had done. He had been tempted to kill two or three persons on the road, but had abstained; at length he killed "a poor little boy in a field," afterwards washing the blood from his hands. He conducted the parish constable to the spot where his victim lay, the head beaten to a pulp and the throat cut from ear to ear, severing the head nearly from the trunk. He could not bear to look at the body. He stated that he had been reading of murders in the newspapers till he thought he must commit one, that the thought had been in his mind for a week, that he was compelled to do it, that he did not wish to kill the boy but could not resist it, that he knew he was doing wrong but had no power to resist. The judge, in summing up, said that there was no assignable motive, that the victim was an absolute stranger; that A. H. had been from boyhood of weak intellect, and that all the witnesses concurred in the opinion that he was not "in a state of sound mind." And yet the jury were to decide on the condition of his mind "at the time he committed the act," whether "at the time he committed the offence he was in such a state of mind as not to be responsible for the act;" "whether he knew he was doing wrong;" "whether he knew

the difference between right and wrong." The jury, taking no notice of these questions, (so strange in the face of the man's own confession) acquitted the prisoner *on the ground of insanity.*

Legal Relations of Imbecility.—In respect to this form of mental unsoundness, two kinds of questions may arise—questions of *competency*, and questions of *responsibility.*

The *competency* of imbeciles to form contracts, and their validity when formed, has often engaged the attention of our law courts. Persons of weak mind have been brought by improper influence to ally themselves in marriage, the validity of which has been successfully disputed, as in the case of Portsmouth *v.* Portsmouth. In this case, as in others that might be cited, the proof of imbecility was rightly drawn, not from a few isolated facts, but from the history of the whole life, conduct, and character.

The competency of imbeciles to manage their affairs is often called in question. As the conduct of life partly depends on a knowledge of the use and value of money, partly on judgment and discretion, such inquiries may assume a very simple or a very complicated shape.

In rare instances men have been pronounced incapable on the ground not so much of general weakness of intellect, as of defective knowledge of numbers and the value of money. Two such cases are related by Abercrombie, in one of which there was a "total inability to perform the most simple process of arithmetic," and in the other "a total want of the power of tracing relations both as to time and numbers." In the face of evidence showing that they had made much progress in their education, both were pronounced incapable of managing their affairs.

An imbecile in whose case we were called to give evidence, did not know how many pence there were in a shilling or sixpence, or how many shillings in a sovereign; could not perform the easiest operation of arithmetic; did not know the date, month, or year; or the name of the reigning monarch; nor recognise persons with whom he had conversed only four days previously. His attention was roused with the utmost difficulty, and could not be fixed to any one subject. His look was vacant, his dress peculiar, his gait awkward, his motions grotesque, his speech slow and hesitating. He used the same words and expressions again and again, repeated imperfectly the tasks and prayers of his childhood, and imitated the contortions of persons, like himself, subject to fits. Such a case could present no difficulty either to witness or jury (G.).

More difficult questions arise in respect of persons who though

they display many marks of imbecility in childish ways, eccentric habits, violent passions, and cruel dispositions, are yet able to perform the simple operations of arithmetic, know the value of money, and can comprehend such statements and suggestions with respect to their affairs as are submitted to them. In some of these cases, a successful appeal has been made to the efficient manner in which the party has actually conducted his own affairs.

The proof of imbecility, combined with undue influence, has, in many instances, been held to invalidate a will; but, in the absence of such influence, all that is required to establish the wills of people of weak understanding is, that they should have been capable of comprehending their nature and effect.

The question of *responsibility* for such acts as arson and murder can only be answered by weighing well all the circumstances of the act, and the whole life and character of the accused; and ascertaining the motive by which the act was instigated (if any exists). It is in imbeciles more than in other persons of unsound mind that the test of a knowledge of right and wrong utterly breaks down.*

Cretinism.—In many parts of the continent of Europe, especially in valleys lying among hills, but occasionally in unhealthy rural and urban districts in all parts of the world, a disease prevails which combines the extreme of bodily deformity and degeneracy with deficiency of intellect. In Switzerland and Savoy persons so afflicted are called *cretins*, and in France *cagots*. The morbid feature by which they are chiefly distinguished is the enlargement of the throat, known as *goitre* or *bronchocele;* but to this several bodily defects and deformities are superadded. The stature is dwarfed, the belly large, the legs small, the head conical, the arch of the palate high and narrow, the teeth irregular, the mouth large, the lips thick, the complexion sallow, the voice harsh and shrill, the speech thick and indistinct, the eyes squinting, the gait feeble and unsteady, the sexual power weak or wanting.

The best authorities represent this physical degeneracy, with the co-existing mental deficiency, as dating, with rare exceptions from a period subsequent to birth. About the fifth or sixth month, the bodily development seems to be checked. The child is weak, and looks unhealthy; the head is large, and its bones widely separated; the belly swells and the limbs shrink; teething goes

* Several interesting and instructive cases of imbeciles, concerning whom the two questions of competency and responsibility have been raised, are given in detail, and made the subject of judicious commentary in Ray's 'Treatise on the Medical Jurisprudence of Insanity.'

on very slowly, and the child cannot stand or speak till its fifth or sixth year. Some cases are complicated with spinal distortion, some with hydrocephalus.

These weak-minded persons are usually classified as cretins, semi-cretins, and the cretinous, or cretins of the third degree.

The first class answer to the description of idiocy already given, with the addition of the peculiar deformity of the throat. Their life is automatic; they have no intelligence; their senses are dull, or wholly wanting; they cannot speak; their time is spent in basking in the sun or sitting by the fire; and only the most urgent calls of nature rouse their attention. They do not possess the power of reproduction. The next class (semi-cretins) can be taught to read and to repeat prayers, but do not understand what they learn; they have no idea of numbers; they note what passes around them, and use words to express their wants, remember common events, understand what is said to them, and speak intelligibly on common subjects. Cretins of the third degree show glimpses of a higher nature, and can attain a certain degree of proficiency in mechanical employments and contrivances, in drawing, painting, and music; but arithmetic is a very rare acquirement. They are said to be acutely alive to their own interest, but unable to manage their affairs, unwilling to take advice, obstinate and litigious.

Cretins of the second and third degrees, if removed from their birth-place early in life, and put under judicious superintendence, improve greatly in body and mind, and may become useful members of society.

DEMENTIA.

This is readily distinguished from the two forms of *amentia* just described. In idiocy the deficiency is congenital; in imbecility it shows itself in early life; but in dementia it supervenes slowly or suddenly in the mind already fully developed, and in childhood, manhood, or old age. It differs also from mania, for it consists in exhaustion and torpor of the faculties, not in violent and sustained excitement.

In dementia we recognise an *acute*, or *primary*, and a *chronic* or *secondary* form. The first is rare, and consists in a state of profound melancholy or stupor; the second very common, and characterized by incoherence, differing from the incoherence of mania by the absence of excitement. Some demented persons, however, are liable to maniacal paroxysms, and maniacs to remissions of comparatively tranquil incoherence. There is also a

Senile Dementia, and a form of dementia associated with General Paralysis.

Dementia also has its degrees or stages of forgetfulness, irrationality, incomprehension, and inappetency. A patient suffering from dementia, as he passes from bad to worse, first exhibits want of memory, then loss of reasoning power, then inability to comprehend, and, lastly, an abolition of the common instincts and of volition. (Prichard.)

1. *Acute Dementia.*—That form of *dementia* which arises from sudden mental shocks, often presents a very peculiar character. The mind is, as it were, arrested and fixed for the remainder of life in sad abstraction on the event which had occasioned it; or the shock destroys all mental power, and brings on a state similar to that of the imbecile or idiot.

During the earthquake panic of 1843, we saw a case of dementia in a lad twelve years of age, brought on by the alarming conversation of a knot of Irishmen in the dusk of the evening. The poor boy seemed deprived of all his faculties, was dull and listless, and answered every inquiry by a vacant smile. He had short fits of terror and excitement, but soon relapsed into stupor (G.).

2. *Chronic Dementia.*—This form may be often traced to some slowly acting cause, such as prolonged grief or anxiety; sometimes it follows attacks of fever, mania, melancholia, apoplexy, paralysis, or repeated fits of epilepsy. In all these cases it may depend on softening or other chronic disease of the brain. It may be inferred from two melancholy cases of recent occurrence that the inhalation of one poisonous vapour at least (mercuric methyl) can induce in healthy men a state of brain passing gradually into the most hopeless dementia, not distinguishable from idiocy.

3. *Senile Dementia*, or that incidental to the aged, is a well-marked form of the dementia which arises from causes acting slowly and gradually. The first symptom is impaired memory of recent events, with dulness of perception and apprehension, and an inability to fix the attention, or follow any train of thought. The things heard five minutes since are forgotten, and the same question is repeated again and again. Hence, the transaction of business requiring sustained attention becomes impossible. The reasoning powers suffer; for scarcely are the premisses laid down before they are forgotten, and the act of comparison by which the conclusion is arrived at cannot be performed; and after pursuing the same topic of conversation through part of a sentence, some accidental suggestion turns the ideas aside

Persons so affected know their attendants and recognise their friends, but they seldom display signs of emotion on seeing them; and they can still employ themselves mechanically,—men in writing, and women in knitting and sewing. The next phase of the malady is one of complete incomprehension. Memory, reason, and the power of attention are entirely lost; but the muscular force remains intact, and displays itself in perpetual activity, in jumping or running to and fro, or walking round in a circle, or rocking backwards and forwards in a chair, dancing, singing, and shouting, or in talking or muttering incessantly. Many, however, sit silent and tranquil, or with a vacant unmeaning stare for weeks, months, or even years. A few remain crouched in one uneasy posture, or they stand erect with the neck rigidly fixed at right angles to the body. Some display obstinate delusions. In the last stage of all, even the animal instincts are lost; there is neither perception, memory, thought, nor reason, but bare physical existence; with occasionally, at distant intervals, a short resuscitation of some of the mental powers.

4. *General Paralysis* (*Paresis*).—The weakened state of the mind in this form of dementia shows itself in most cases by delusions of unlimited power and boundless wealth; in all by progressive decay of bodily and mental power. Among the early symptoms are neglect of duty, a restless and wandering disposition, the commission of petty thefts, indecent exposure of the person, acts of extravagance, and a sudden change of opinion and feeling, moral and religious. This disease is rare in women, common in men of education and position; and it generally shows itself in adults of middle age—from thirty to sixty. Its causes are intemperance, sexual excesses, the anxieties and undue mental labours of the active and stirring period of life, and hereditary taint. The mental defect is sometimes recognised before the paralysis, sometimes with it, and sometimes the spinal marrow is first affected, then the structure and functions of the brain. Its duration is usually stated at from a few months to three years. The paralytic symptoms show themselves first in the tongue, lips, and features. The articulation is hesitating and indistinct; the lips, tongue, and muscles of the face are tremulous and quivering; the pupils often unequal. Then the muscles of the limbs are affected. The patient trips, stumbles, and staggers, and can no longer perform such combined muscular movements as playing on musical instruments, writing, and sewing. The paralysis increasing and extending, at length attacks the sphincters, and the muscles engaged in the act of swallowing, so that it is not uncommon for death to happen from suffoca-

tion. The gradual descent towards death, marked by increasing weakness and helplessness, is interrupted by occasional violence and fits of epilepsy. Sloughing bed-sores, with diarrhœa or pneumonia close the scene. One noteworthy and characteristic feature of the malady shows itself at an early stage. The relaxation of the muscles causes the wrinkles of the face to disappear, and the patient to look younger; but later on, the face becomes curiously wanting in expression. But the mental characteristics remain the same, and the last muttered words are about "gold, and carriages, and millions of money."*

The figures annexed (30 & 31) represent the early and advanced stage of General Paralysis in a gardener, æt. 38. The mis-

Fig. 30.

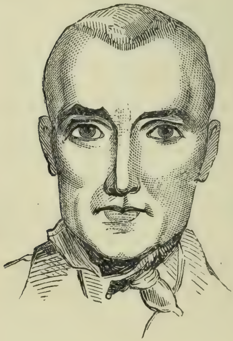


Fig. 31.

conduct of a daughter brought on a state of melancholy; and at the end of a fortnight he began to insist that he was a king with a million of money, living in a palace made of gold. His memory failed him, he did not know the month or year, his speech was slightly impaired, but his walk was tolerably firm. Fig. 30 was taken a month after the appearance of these symptoms, and fig. 31 after the lapse of another month, when the disease had made much progress, shown by increased embarrassment of speech, nearly utter loss of memory, tottering gait (for he could scarcely walk at all), and, notwithstanding a very good appetite, rapid emaciation.

Legal Relations of Dementia.—Dementia is a common subject of the inquiry *de lunatico*. A demented person lapses into

* L. Meyer: quoted by Maudsley in his 'Physiology and Pathology of the Mind,' p. 164.

habits of ruinous extravagance, and the inquiry has for its object to ascertain whether he is able to manage his affairs, and if not, since what date. To this inquiry, difficult in itself, the rival interests that always grow up round persons of this class, oppose peculiar obstacles.

A question frequently raised respecting persons suffering from this form of unsoundness, relates to the validity of wills made or altered by them; and the same question is apt to arise in cases of senile dementia. The inquiry is generally a difficult one; for such persons vary greatly from day to day, and present themselves to different observers in different lights. Hence conflicting testimony, and wide divergences of opinion, both among unskilled and skilled witnesses; and the legal decision ultimately turns much more on the character of the will itself and its consonancy, or otherwise, with the known intentions and views of the testator at an earlier period of his life, and with the natural feelings of persons of sound intellect, than on the medical or other evidence respecting his mental condition.

General paralysis, in all its degrees, affords a strong presumption against the competency of the subject of it, for it implies, as a general rule, exaggerated ideas of wealth, and consequent inability to make a reasonable use of money.

The responsibility of the demented for acts which in the sane are crimes will be considered presently.

MANIA.

This term includes all the forms of unsoundness that are characterized by undue excitement; and it therefore differs widely from those already described. There is no legal term in common use which rightly characterises this state; and one of its most important forms, moral insanity, is as yet unrecognised by the law. The only legal term used in a sense analogous to that of mania is *lunacy*, which, as already remarked, is objectionable from being founded on a feature of the disease not present in all cases.

There are three forms of Mania (Table, p. 172); *General*, *Intellectual*, and *Moral*; the two latter having each two subdivisions—*General* and *Partial*.

General Mania.—This form affects the intellect, the emotions, and the passions, and throws the whole mind into a state of mingled excitement and confusion. It is the counterpart of the incoherence of dementia, and the form which, in some cases, mania assumes from the very first. It would be correctly designated "raging incoherence." There is another form liable to be con-

founded with this, on the one hand, and with monomania on the other, but which, when carefully examined, is found to be a general unsoundness, with undue excitement of some predominant emotion or passion that takes the lead in the unsound, as it had previously done in the sound mind.

Mania, whatever its form, unless it be the immediate consequence of injuries, moral shocks, intoxication, poisoning, or acute disease is commonly preceded by important bodily and mental changes, which occupy a variable period, from a few days, to 15 or 20 years. This is known as the period of *incubation.*

When the period of incubation is short, the disease shows itself at the end of some hours or days of anxiety, uneasiness, and sadness, by headache, sleeplessness, and excitement. The patient begins to babble, cry, and sing, becomes wild and agitated, and seems like a person intoxicated. When the period is extended, the disease generally begins with a consciousness of some disorder of the mind, characterised by odd notions, unusual inclinations, and changing affections. The patient is vexed at the change, and tries to conceal it; continues his occupations; and, like a man in the first stage of intoxication, makes great efforts to appear reasonable. Meanwhile his health gives way. His sleep is disturbed; he loses flesh and appetite; and suffers from indigestion and constipation. A great change also takes place in his tastes, habits, affections, and character, and in his aptitude for business. If he was gay, communicative, and social, he becomes sad, morose, and averse to society; tears and laughter succeed each other without apparent cause; if open and candid, he becomes suspicious and jealous; if moderate in his political and religious opinions, he passes to an extreme exaggeration in both; if affectionately attached to wife, children, and relations, he regards them with indifference or dislike; if he was orderly and economical, he becomes confused and prodigal; if correct in conversation, his language becomes violent and obscene; if chaste or moderate in sexual indulgence, he becomes the victim of insatiable desires, and either seeks to associate with the other sex, or has recourse to disgraceful practices.

If this is a first attack, he is apt to be misunderstood; and to be harassed and pained by indiscreet questions, offensive insinuations and frivolous accusations; and when, at length, he breaks out into furious mania, the attack is attributed to some quite inadequate cause.

The period of incubation passed, and the disease fully established, the patient has faith in his delusions, and instead of concealing his thoughts, openly and strenuously avows them, except

when tempted by powerful motives to a contrary course. When thwarted and opposed he uses the most violent, obscene, and insulting language, tears his clothes and bedding to pieces, and inflicts bodily injury on himself and those about him. The face is flushed, the eyes wild and sparkling, he complains of ringing in the ears, pain, weight, and giddiness in the head. He is restless and sleepless; he is insensible to heat and cold, and either abstains from food and drink during long periods, or eats voraciously. His habits are often most disgusting and offensive. His muscular power is inordinately developed, and he sustains for a long time without sleep, a succession of efforts which would soon utterly exhaust a healthy person.

The features of the maniac during the fit wear an expression not merely of fierce excitement, but are often so changed as to be hard to recognise. The annexed figures give some idea of this contrast. Fig. 32 shows an epileptic maniac, æt. 60, in a paroxysm, and fig. 33 the same person, calm, collected, and well behaved.

Fig. 32.

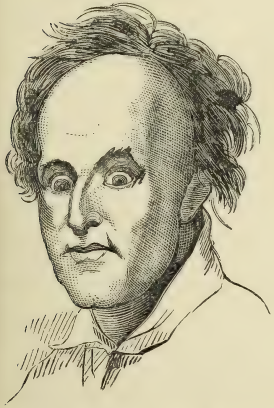
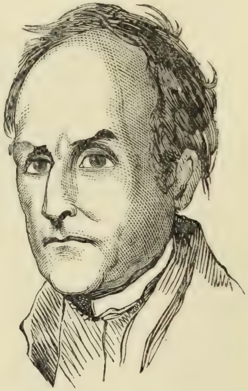


Fig. 33.



General Intellectual Mania.—The opinion is gaining ground that mania is in all cases primarily an emotional disease, and that the affection of the intellect is secondary. But there is certainly one exception in a class of cases in which the senses are the sport of illusions, not isolated, but grouped together,

and following each other so as to differ in no respect from the mixed experiences of real life; these being converted from illusions into delusions by the act of belief, constitute the whole of the mind's unsoundness; and they may be fitly designated "*Illusional Insanity.* Of this we have three good examples in the estimable gentleman of Argos, immortalized by Horace,

> "Qui se credebat miros audire tragædos,
> In vacuo lætus sessor plausorque theatro;"

in another at Abydos, mentioned by Aristotle, and in the patient of "exalted rank" whom Sir Henry Halford saw in his fancied theatre, and heard "call upon Mr. Garrick to exert himself in the performance of Hamlet." In an analogous form of illusional insanity, a series of illusions of sight, sound, and touch, are woven into a continuous tale of wonder, as happened to a well-known artist who gave an account of his experiences in 'All the Year Round' for October 5, 1861.

There is still another class of cases in which some single object appears to impress the senses so strongly, that the mind by a strange kind of illusive transformation, completely identifies itself with the object in question. Such was the case of a gentleman who thought himself secretary to the moon, but does not seem to have carried his unsoundness into sublunary affairs, and of another who thought himself the Crystal Palace.

But there is certainly a very distinct and well-marked class of cases wrongly regarded as intellectual, though really dependent on the excitement of some strong emotion or passion, such as pride, vanity, or ambition, of which Dr. Reid gives us a good example in a vain young medical student, who, expecting to realize a fortune by academical honours, entered himself at Cambridge, and so injured his health by fruitless application to study, as at length to fall into a state of decided derangement, alleging that he was the Farnese Hercules; had written Dr. Clarke's Travels in Russia; had composed Virgil's Æneid; had painted one of the masterpieces of Raffaelle, and knew everything.

Dr. Henry Johnson, (The Arrangement and Nomenclature of Mental Disorders) gives the highly characteristic letter of one who claimed the incongruous titles of champion and king of England, and heir presumptive to the Crown, at the same time that he monopolized all the principal offices of State.

A patient of ours, who after indulging for years in a series of strange and indecent acts, only to be accounted for by moral insanity, had an attack of general mania, followed by brain-softening; in which state he claimed to know all about the

human body, as having made it, to be the Christ, king of England, and heir apparent, to have written a universal history, in a curiously short space of time, and to be in possession of untold wealth (G.).

The autobiography, already referred to, of a gentleman who had recovered from an attack of mania, shows how general was the disturbance of the whole intellectual and moral being; though the predominant emotion being of a religious character, the case might have been described as one of religious monomania.

General intellectual mania consists, then, in many cases, in a violent disturbance of all the intellectual faculties brought about by the over-excitement of some one leading emotion or passion.

Partial Intellectual Mania.—This was called melancholia, from the mistaken notion that such partial affections of the intellect are always of a gloomy character. But Esquirol showed that such persons have often extremely gay and pleasant ideas, and substituted the term monomania, now generally received.

The simplest form of this disorder is that in which the patient takes up some one notion opposed to common sense and universal experience. He is secretary to the moon, the Crystal Palace, a grain of wheat, a goose-pie, a pitcher of oil, a wolf, a dog, or a cat.

In many cases, this single delusion relates to, or is caused by, some sensation or disease, which the monomaniac, like the dreamer, associates with imaginary accompaniments. Thus, Equirol tells us of a woman who having hydatids in the womb, insisted that she was pregnant with the devil: of another, who having adhesions of the intestines after chronic peritonitis, imagined that a regiment of soldiers lay struggling and fighting in her belly; of a third, who, suffering in the same way, believed that the apostles and evangelists had taken up their abode in her bowels, and were occasionally visited by the Pope and the patriarchs of the Old Testament.

These delusions, though originally founded on real sensations, may continue after the sensations themselves have passed away, as is proved by the cures that have been wrought by a laudable species of deception. Thus, a patient, thinking that a serpent had been extracted from his bowels by a pretended surgical operation, took up the idea that the creature had left its ova behind ready to be hatched into a brood of young ones; but was reassured by the dexterous reply, that the snake was a male.

But such cases of partial intellectual mania do not comprise all those designated as *monomania;* for in most instances the mental affection goes beyond a single insane idea, and influences

more or less extensively the thoughts and the conduct, being marked by other intellectual and moral inconsistencies.

Moral Mania.—Pinel first recognised this form of unsoundness, the disease having been previously considered as wholly, or chiefly, a malady of the reasoning faculties. He found at the Bicêtre, to his great surprise, many maniacs "who betrayed no lesion whatever of the understanding, but were under the dominion of instinctive and abstract fury, as if the affective faculties alone had sustained injury." This he called *manie sans délire.* The reality and importance of this distinction between intellectual and moral mania are now recognised by all who have experience of the insane; as well as the fact that the first generally precedes the second. Prichard, an able writer on this subject, defines moral mania as "a morbid perversion of the natural feelings, affections, inclinations, temper, habits, and moral dispositions, without any notable lesion of the intellect, or knowing and reasoning faculties, and particularly without any maniacal hallucination."

Moral mania, like the intellectual form, may be either *general* or *partial.*

General Moral Mania.—Prichard observes that there are many persons living at large in society who are reputed to be singular, wayward, and eccentric. An attentive observer will recognise something remarkable in their manners and habits which may lead him to doubt their sanity; and often on inquiry his suspicions are strengthened by finding that an hereditary tendency to madness exists in the family, that several of the relations have laboured under other diseases of the brain, or that the individual himself has formerly had a decided attack of madness. His temper and disposition are found to have changed; to be not what they were previous to a certain time; and the change may perhaps be traced to a period when he had a reverse of fortune, or lost some beloved relative, or sustained some severe shock, some febrile or inflammatory disorder affecting the brain, a slight attack of palsy, or a fit of epilepsy. In some cases, the alteration in temper and habits has been gradual and imperceptible, consisting apparently in an exaltation or increase of peculiarities always more or less natural and habitual. These persons are capable of reasoning or supporting an argument on any subject within their sphere of knowledge; and they often display great ingenuity in justifying and explaining their feelings and conduct. In one sense indeed, their intellectual faculties may be termed unsound; they think and act under the influence

of the same strongly-excited feelings which render sane persons proverbially liable to error both in judgment and conduct.

Hoffbauer, too, recognises this moral form of mania. "It is clear," he says, "that mania may exist uncomplicated with mental delusion; it is, in fact, only a kind of mental exaltation (*tollheit*), a state in which the reason has lost its empire over the passions and the actions by which they are manifested, to such a degree, that the individual can neither repress the former, nor abstain from the latter. It does not follow that he may not be in possession of his senses, and even of his usual intelligence, since, in order to resist the impulses of the passions, it is not sufficient that the reason should impart its counsels,—we must have the necessary power to obey them." Esquirol not only recognised this form of unsoundness, but even declared "moral alienation to be the proper characteristic of mental derangement," adding that though "there are madmen in whom it is difficult to find any trace of hallucination, there are none in whom the passions and moral affections are not perverted and destroyed."

Several striking cases of Moral insanity are to be found in the works of Prichard and Ray; perhaps the most remarkable among which is that of Frederick William of Prussia, father of Frederick the Great. He was a drinking and smoking hypochondriac, and the strange, wayward, and cruel tyrant of his family and household. His religious austerities, his disgusting and brutal behaviour to his children, his unfounded hatred of his own son, and repeated attempts on his life, his one attempt on his own life, his steady and unswerving persecution of the innocent objects of his suspicion and dislike, without any delusion beyond that which might fairly be regarded as the offspring of his hate —present a striking picture of general moral mania.

Maudsley* gives us as "the extremest example of moral insanity" he has seen, the case of an old man, æt. 69, who had been in one asylum or another for fifteen years. He had great intellectual power, could compose well, write tolerable poetry with much fluency, and was an excellent accountant. He had no delusion, but "morally he was utterly depraved." He would steal and hide whatever he could, and several times escaped from the asylum with marvellous ingenuity. He then pawned what he had stolen, begged, and lied with such plausibility that he deceived many people, until he got into the hands of the police, or was found in a wretched state in the worst company in the worst part of the town. He had been several times in

* The 'Physiology and Pathology of the Mind,' p. 317.

prison for stealing. In the asylum he was most troublesome, cunning, plausible, and treacherous; abusive, foul, and blasphemous in language; drew indecent pictures, and was guilty of most indecent acts. At long intervals, sometimes of two years, he fell into profound melancholy for two or three months, refused food, and was as plainly insane as any patient in the asylum. "In short, he had no moral sense whatever, while all the fault that could be found with his very acute intellect was, that it was entirely engaged in the service of his depravity."

Partial Moral Mania.—This consists in the intense activity of some one passion or propensity, and its predominance or complete mastery over every other. The persons so affected are usually perfectly conscious of their condition, and either evince the utmost horror at the conduct to which their ruling passion would impel them, and with difficulty restrain themselves, or they give way, as if in desperation, to the impulse.

There is no strong impulse of our nature that may not be thus placed, by morbid excitement, beyond the restraint of reason and conscience. The following forms are now generally recognised, and have received distinct names:—Kleptomania, Erotomania, Pyromania, Dipsomania, Suicidal Mania, Homicidal Mania. These are of special interest to the public and the legislature; but there are many other distinct varieties, some marked by extreme depression, and others by great excitement, which have been classed under the two heads of *Melancholia* and *Exaltation*, the first comprising the three species, hypochondriasis, nostalgia, and religious despair; the second, excessive pride, vanity, or ambition.

Kleptomania, or *Propensity to Theft.*—Many persons placed by their wealth beyond the reach of vulgar temptation, are subject to this form of unsoundness; women being more liable to it than men. It is also a common feature of imbecility and of mania, and an incident of maniacal paroxysms. Prichard mentions the curious case of a madman who would never eat his food unless he had stolen it.

Erotomania, or *Amorous Madness.*—This disease, known as *Satyriasis* when it attacks men, and *Nymphomania* when it occurs in women, sometimes afflicts virtuous females, who view their excited passions with horror and remorse.

Pyromania, or *Propensity to Incendiarism.*—This, in common with Kleptomania, is more frequent in women than in men, especially in young girls subject to menstrual suppression or disturbance. It also prevails among the imbecile tramps who infest our rural districts.

Dipsomania.—An excessive craving for drink, in some cases continuous, in others intermittent, is a well-recognised form of partial moral mania. It may also be part of a more general unsoundness, and the insane source of all the patient's manifestations. He is perfectly rational when not under the influence of drink.

Suicidal Monomania.—The fact of suicide having been practised and sanctioned by philosophers and lawgivers of past times, and of being still in common use in nations which have attained in many respects a high civilization, such as China and Japan, has led some to the belief that it is not always the result of insane impulse. The calm and deliberate manner in which the act is often set about, and the plausible reasons alleged in its defence tend to confirm this view. Those who recognise a "folie raisonante," or have seen cases such as that which once came under our own notice, of a young man who had displayed high talents, and achieved great distinction both at school and college, crowning a series of abortive attempts at suicide with one success, describing his own mental state in terms of singular clearness, as one to which we can attach no better epithet than *mental malaise* (G.), will not attach much importance to this doubt; * but they will find a better reason for believing it to be, at least occasionally, independent of insanity in the fact, that in France two persons often combine for the purpose of self-destruction; such union of purpose being extremely rare in the case of the insane. Our own experience of suicide leads us to believe that it is often the result of a sudden impulse, on very slight provocation, of persons not previously depressed in mind (G.).

The argument drawn from national usage in ancient and modern times has no great force; for who would hesitate to characterize an English widow who should burn herself on the death of her husband, as insane? though such self-sacrifice was once a laudable custom in India; or though some savage tribes eat human flesh, refuse to look upon the act of the French woman who killed her child, cooked and ate of it, and offered the dish to her husband, as strong evidence of insanity? Who, again, can refuse to believe that a most degrading practice to which whole nations in the East are largely addicted, is in many of the cases, which occur among ourselves, a true madness of the flesh. If a man of high social position, and possessed of a princely fortune, is held to be a moral maniac if he cannot help stealing, surely one surrounded by all the refinements of modern society, and

* This case belonged to a painful class in which a solitary vice indulged to excess in youth, and perhaps abandoned, lays the foundation of a shattered nervous system, and leaves a legacy of unavailing regret.

who yet indulges in this disgusting practice, may be safely placed in the category of partial moral maniacs.

That very many cases of suicide are the result of insane impulse does not admit of doubt; and this conclusion is strengthened by the frequent attempts at self-destruction made by some inmates of lunatic asylums, the strange modes of death sometimes selected, and the fact that several members of the same family often succumb to it in turn. It may be added, that such high authorities as Foderé and Esquirol have strongly maintained the necessary dependence of suicide on insanity.

Homicidal Mania.—The best authorities, both at home and abroad, have recognised this form of mental unsoundness as existing independent of delusion. The recorded cases are now very numerous, and comprise instances of successful resistance to the impulse, voluntary submission to restraint, and failure. Women seem to be more liable than men to this form of moral mania, even if we set apart some cases of infanticide as special instances of it. Women weakened by grief or anxiety, by habitual discharges, at the menstrual period, at the change of life, and soon after delivery, are thrown into a peculiar nervous state, known as *mimosis inquieta,* sometimes accompanied by a strong impulse to crime, with an overwhelming dread of giving way to it.

Puerperal Mania.—This is named after its cause, and not after any leading symptom. It attacks women who have been recently confined, generally at some period between the first suckling of the child and the last show of the lochia, and is sometimes occasioned by the suppression of the secretions of the breast or womb, but sometimes also in consequence of excessive lactation or profuse vaginal discharge, of great weakness however induced, or of want of sleep. The disease is rare before the third day; most common between the fifth and fifteenth. The symptoms may be those of any leading form of unsoundness; in many cases there is a strong homicidal tendency, and the child falls a victim to a sudden impulse, there being no assignable or imaginable motive, no concealment, and often no remorse. (See a case of puerperal mania at p. 134.)

Melancholia (Lypemania of Esquirol).—There are three principal forms of melancholia, all characterized by profound sadness; *hypochondriasis,* consisting in a desponding view of the condition of the body and of the health, often, but not always, based on uneasy bodily sensations and disorders of the digestive organs; *nostalgia,* or an intense longing for country and home; and *religious despair.* The extreme form of melancholia, associated with some terrible delusion, in which the patient is fixed in one

position, like a statue, has been distinguished as *melancholia attonita.* To these three forms of melancholia may be added with propriety, cases of *mental malaise,* or simple misery, of which an example is given under the head of *suicidal monomania* at p. 205.

Exaltation.—This opposite of melancholia prevails in those who exult in the belief that they are possessed of great personal attraction, great power, great dignity, great inventive faculties, or great projects of benevolence.

Melancholia and exaltation sometimes alternate in the same patient with some approach to regularity, constituting the form of unsoundness to which some French authors have given the name of *folie circulaire,* or *folie à double forme.*

Cases also abound, both inside and outside of our asylums, which warrant the use of a larger vocabulary of terms—cases, for instance, in which a lying or begging propensity, or a strange pleasure in the act of giving or spending money, is quite as clearly marked as a thieving propensity in those designated as Kleptomaniacs. Nor is it possible to omit the remarkable recorded cases of *lycanthropy,* one of which (that of the soldier Bertrand) occurred not many years since in France, the violation of the grave being with him an intermittent insane passion, which no sense of personal danger was allowed to disappoint.*

The longings of pregnant women, carried to a strange excess in one who killed her husband, and pickled his body, to eat it (Maudsley); a persistent morbid desire to be hanged; and the killing of children by their fathers or mothers with the sincere purpose of sending them to heaven—might also be properly described as distinct and well-defined forms of partial moral mania.

Of Mania with Lucid Intervals.—Mania, in many cases, assumes a recurrent or intermittent form, the patient in the interval being in his right mind. The proportion which these cases bear to those of complete recovery has been variously stated at from one in six to one in ten.

The interval is various. Esquirol has seen a quotidian, tertian, and quartan type, as well as intervals of a month and a year. More frequently the intervals and durations of attacks are alike uncertain. This recurrent mania, with intervals of complete sanity, must not be confounded with those periods of comparative tranquillity which, like lulls in a storm, occur in most cases of mania. Of such intervals, Haslam remarks as the result of more than twenty-five years' experience, that "he cannot affirm that

* Nor can we refuse to recognise, in some cases at least of unnatural lust, a *madness of the flesh.*

the lunatics with whom he had daily intercourse, have manifested alternations of insanity and reason. They may at intervals become more tranquil, and less disposed to obtrude their distempered fancies into notice. For a time their minds may be less active, and the succession of their thoughts consequently more deliberate; they may endeavour to effect some desirable purpose, and artfully conceal their real opinions; but they have not abandoned or renounced their distempered notions."

Legal Relations of Mania.—The law views civil acts done in a *lucid interval* as performed by one in a permanently sound state of mind; it acknowledges the validity of wills made during such an interval, and has, in more than one case, admitted the reasonableness of the will as proof of its occurrence. With regard to criminal acts, it makes a reasonable distinction; for it regards the condition of unsoundness as one readily reproduced by provocation or excitement. The legal relations of the other forms of mania will be considered in the following division.

IV. OF THE MORE IMPORTANT CHARACTERS OF THE UNSOUND MIND, AND OF ITS MEDICAL AND LEGAL TESTS.

A knowledge of the leading characteristics of mental unsoundness is of the first importance both to the lawyer and to the physician. Without it, a mere description of its several forms would present but an imperfect view of the subject. It is proposed, therefore, to establish, by appeals to facts, the more remarkable phenomena of mental unsoundness, as preliminary to the discussion of the chief legal questions that arise out of that state.

Of the Characters of Unsoundness of Mind arising from Defective Development or Diminished Activity.

The appearance of the idiot or imbecile is so peculiar, that it scarcely needs to be confirmed by an inquiry into his mental condition. Difficulty in rousing and fixing the attention; slowness of apprehension; forgetfulness of recent occurrences; ignorance of social relations, of such familiar things as his age, the place in which he lives, the mode in which he passes his time, the year, the month, the day of the month and week, and of those public persons and events which are the usual topics of conversation with all who take an interest in the common affairs of life, as the name of the reigning monarch, of the prime minister, &c.; a scant acquaintance with arithmetic and the value of money; an imperfect knowledge of right and wrong, and of the law relating to the most common and familiar crimes; may be mentioned among the characters of unsoundness from defective development.

In the majority of cases of imbecility there is no difficulty in deciding on the competency of the individual to take care of his own affairs, to form contracts, to devise property; but in a few cases, and especially when the subject of inquiry has been entrusted with, or consulted about, the management of his affairs the question is not so easy. But a comparison of the existing with the former state of mind (a procedure which seems to have been strangely overlooked till the interesting case of Mr. Edward Davies gave Dr. Gooch the opportunity of pointing it out, and insisting on its importance),* supplies a simple and obvious test.

The tests of capacity usually recommended in cases of imbecility are obviously insufficient to determine whether or not a man is capable of managing his own property. The arithmetical test, on which so much stress has been laid, is a test of knowledge, not of power. A man may be the best accountant in the world, but he may be a moral imbecile and have so mean a sense of right, so childish a fancy, and so weak a will, that from infancy to age he may yield to every impulse, and gratify every whim without once counting the cost. A patient of our own, with whom we had been intimate for years, owed pence as a child, and pounds as a boy, and added debt to debt with each year that passed over his head, till at length a severe disappointment brought on a distinct attack of mania, of which a benevolent but extravagant mission, violent outbursts of passion, and fierce hatreds, arrangements to spend a year's income in a week, and the unfounded expectation of an immense fortune on the morrow, were constituent parts. He carried with him to an asylum a host of delusions, and died in the firm conviction that he was the Saviour of mankind. In this case there was the cultivated and refined intellect of a man with more than the weakness of a child; but no test could have proved him incapable of managing himself and his affairs, save only the history of his life (G.).

The criminal acts of persons of weak intellect are as strongly marked by folly as their words and actions. They have no surer characters, and we no better test. But in this case, as in that of maniacs, the law insists upon the test of a knowledge of right and wrong, which is as insufficient in criminal, as the arithmetical test in civil cases. It is a test of knowledge, not of power; and the knowledge of right, and the power to act aright are as distinct as science and art.†

* See 'Quarterly Review,' 1830, and the first edition of this work.

† Questions have arisen in reference to the intelligence and testamentary capacity in *aphasia*. It is a matter of every day observation

Of the Characters of Unsoundness of Mind from Excessive Activity.

In tracing the more prominent characters of this division, or, in other words, of mania, the term will be used in its most extended sense as applied to those cases (and they are the great majority) in which the intellect, the affections, and the passions, are jointly implicated, whether there be one delusion or many, or merely some one excited emotion or passion, the source of a thousand changing fancies. This inquiry will prepare the way for an examination of the plea of insanity in criminal cases.

1. *In mania, consciousness, memory, and reason may remain intact, even in the midst of the most violent paroxysms.*—The doctrine that mania is primarily an emotional disease is quite consistent with this proposition. It is quite conceivable that the emotions and passions may be subject to the most violent excitement, constant or intermittent, and yet the patient retain the use of reason, a perfect consciousness of all the relations in which he stands towards others, and a vivid recollection of every occurrence in which he has borne a part. It is true that in the actual paroxysm of maniacal excitement there can be neither time nor place for acts of comparison or processes of reasoning, and that conscience may lose all restraining power; but that memory may remain intact, even in the most violent maniacal outbursts, is certain. We were consulted in the case of a lady, a maniac of long standing, subject to frequent paroxysms of extreme violence; in one of which she destroyed some valuable papers belonging to her husband; and yet after the lapse of twenty years, in a tranquil interval, she reverted to the occurrence, and expressed her regret at what had happened. We have found similar evidence of accurate recollection in the autobiographies and *vivâ-voce* histories of convalescents from mania (G.).

Of the intact condition of the higher mental faculties in the maniac's more tranquil moments, no medical evidence need be adduced. It will suffice to quote the words of Erskine, used at the trial of Hadfield. "In all the cases," he says, "which hav

that there may be total loss of speech, and of the power of expressing idea in writing, and yet the individual so affected may be able to signify hi meaning by gestures and discriminate between the right and wrong appella tion of things. It is perfectly feasible for such an individual to make know his intentions in response to well directed interrogations. But there ar other cases in which there is very considerable improvement in the power o comprehension of the meaning of words, and in the intelligent expressio of ideas and desires. No absolute rules can be laid down applicable to al cases, and evidence would have to be taken in each particular case in whic the question of capacity might arise.

filled Westminster Hall with the most complicated considerations, the lunatics, and other insane persons who have been the subjects of them, have not only had memory *in my sense of the expression* —they have not only had the most perfect knowledge and recollection of all the relations they stood in towards others, and of the acts and circumstances of their lives, but have in general, been remarkable for subtlety and acuteness. Defects in their reasoning have seldom been traceable,—the disease consisting in the delusive sources of thought,—all their deductions, within the scope of their malady, being founded on the *immovable* assumption of matters as *realities*, either without any foundation whatever, or so distorted and disfigured by fancy, as to be nearly the same thing as their creation."

The madman, then, reasons like other men, with this difference, that his delusions being stronger than the imaginations of sane men, and his passions more violent, reason is more readily made the advocate of the one and the slave of the other; and this is true of all the faculties of the mind, and even of the senses.

2. *The senses are deceived and confounded.*—Illusions of sight and hearing, and illusive transformations of real sensations, are, it is well known, among the most general accompaniments of mania. The author of the autobiography referred to at p. 175, says:—"My senses were all mocked at and deceived. In reading, my eyes saw words on the paper, which, when I looked again, were not. The forms of those around me, and their features, changed even as I looked on them." "I heard the voices of invisible agents, and notes so divine, so pure, so holy, that they alone, perhaps, might recompense me for many sufferings. My sense of feeling was not the same; my smell, my taste, gone or confounded." The conversion of familiar sounds, such as the lowing of cattle, the falling of water, the grating of a chain, the noise of footsteps, into articulate speech, was not the least remarkable feature of this most interesting and instructive case.

3. *The persons by whom the madman is surrounded derive their characters from his delusion.*—To the author of the autobiography the inmates of the asylum and his keepers were supernatural beings. There was a maniac there whom his spirits called the Lord Jehovah, supremely omnipotent, the Trinity in unity; and he took one of the keepers to be the Saviour of mankind. They all underwent the strangest transformations, and according to the state of his mind, were either angels or fiends.

4. *Real impressions on the organs of sense become, as in dreams, the materials of imaginary scenes.*—This also, is strikingly illustrated in the autobiography. The cold air blows on him as he tries to suffocate himself, in obedience to the spirits that speak within him: and he conjures up the spirits of his sisters cooling him with their breath, and encouraging him to go through with his task. The familiar sensation of water trickling down the back is converted into the crystal tears of his father, whose venerable countenance he sees bending over him. His shaven head suggests the notion that he has received the tonsure of a Roman Catholic priest, a mark of the beast. The flames in the grate are the utterance of his father's spirit, striving to save him, and obliged to return to hell-fire, to be purified from the contamination of his foul thoughts. The lowing of the cattle conveys to him articulate sounds and sentences, and his chair grating against the wall speaks to him in his father's voice.

5. *The strange antics of the madman are the effects of his delusion.*—The following passages from the autobiography fully establish this proposition: "I expected to be guided to prayer; but a spirit guided me, and placed me in a chair, in a constrained position, with my head turned to look at the clock, the hand of which I saw proceeding to the first quarter; I understood I was to leave the position when it came to the quarter." "Another delusion I laboured under was, that I should keep my head and heart together, and so serve the Lord, by throwing mysef head over heels over every stile or gate I came to; the condition here was, as before, on its being done in *precision* and *decision*." A keeper throws a patient down and nearly strangles him. "When I saw his bloated and inflamed cheeks, and the eyes starting out of the sockets, I offered to do anything to rescue him. My spirits desired me to whirl myself round and round as fast as I could, which I did till I staggered against the wall, and nearly fell on the stone pavement." This last quotation suggests the corallary that

6. *The madman's acts, the result of his delusions, are such as no sane man would believe fitted to compass the object in view.*

7. *The violence of the madman is often the effect not of passion but of delusion.*—"I knew no malice," says the author of the autobiography, "no vice. I imagined that they (the keepers) loved me, and were all deeply interested in the salvation of my soul, and I imagined, too, that I loved them dearly." Yet he wrestled with the keepers, and struck them many hard blows; sometimes, as he was told, making it difficult for three strong men to control him; yet whenever he did

this, he was told that they wished him to do so, to prove his faith and courage, being commanded to prove both till they were satisfied of his sincerity. "It was always a great delight to me to get my hand at liberty, even for a moment, and the first use I usually made of it was to strike the keeper who untied me; directed by my spirits to do so, as the return he desired above all things else, because he knew I was proving my gratitude to the Lord Jehovah at the risk of being struck myself." Doubtless the keepers regarded this as mere senseless and motiveless violence. Do we not equally misunderstand the criminal acts of the lunatic?*

8. *The maniac, if of a reserved disposition, or when impelled by a strong motive, can conceal his delusion.*—The proof of this proposition may be found in every work on insanity; and a remarkable illustration of it was given by Erskine in his defence of Hadfield. A person who had been confined in an asylum prosecuted his brother and the proprietor for imprisonment and false duress. Erskine was told that the man was undoubtedly insane; but not told the particular form the malady assumed. The prosecutor, himself a witness in support of the indictment, was put into the witness-box and examined; and when Erskine cross-examined him, he found his evidence clear, distinct, collected, and rational. He tried to discover some lurking alienation of mind; but during a cross-examination, conducted with all the skill and sagacity of which he was master, for nearly an hour, he was completely foiled: the answers were perfectly rational—there was not the slightest appearance of mental alienation. But a gentleman who had been accidentally detained, came into court, and whispered in Erskine's ear that the witness thought he was the Saviour of mankind. On receiving this hint, Erskine made a low bow to the witness, addressed him in terms of great reverence, respectfully begged to apologize for the unceremonious manner in which he had treated a person of his sacred character, and called him by the name of Christ. The man immediately said, "Thou hast spoken truly: I am the Christ!" Pinel relates a similar case. A commission appointed to visit the Bicêtre examined one patient repeatedly on many successive days; but they failed to prove him insane. They accordingly ordered a certificate to be prepared for his release; and placed it before him for his signature. He signed "Jesus

* These statements, like others in this instructive autobiography, are singularly in keeping with those of a recovered religious maniac who was for a long period under our observation, and whose memory of past occurrences was singularly clear (G.).

Christ." In a case to which we have already referred (p. 209), we have reason to believe that more than one of the patient's delusions was never mentioned to any one but ourselves, and that only once; nor could he be induced by long conversations framed for the purpose to give the slightest indication of them to third parties; and a lady whose principal delusion was that she was Queen of England, spoke on the subject only to one of her sisters; so that it was only by listening at the open door that we could obtain evidence of the fact (G.).

9. *The acts of the maniac often evince the same forethought and preparation as those of the sane.*—A patient confined in the Manchester Lunatic Asylum, had been cruelly treated by a keeper, and in revenge killed him. He related the particulars of the transaction to Dr. Haslam, with great calmness and self-possession. He said: "The man whom I stabbed richly deserved it. He behaved to me with great violence and cruelty; he degraded my nature as a human being; he tied me down, handcuffed me, and confined my hands much higher than my head, with a leathern thong; he stretched me on the bed of torture, after some days he released me. I gave him warning, for I told his wife I would have justice of him. On her communicating this to him, he came to me in a furious passion, threw me down, dragged me through the court-yard, thumped me on my breast, and confined me in a dark and damp cell. Not liking this situation, I was induced to play the hypocrite. I pretended extreme sorrow for having threatened him, and, by an affectation of repentance, prevailed on him to release me. For several days I paid him great attention, and lent him every assistance. He seemed much pleased with the flattery, and became very friendly in his behaviour towards me. Going one day into the kitchen, where his wife was busied, I saw a knife; this was too great a temptation to be resisted: I concealed it about my person, and carried it with me. For some time afterwards, the same friendly intercourse was maintained between us; but as he was one day unlocking his garden door, I seized the opportunity, and plunged the knife up to the hilt in his back.

10. *The maniac, in spite of his proverbial cunning, is easily imposed upon.*—This forms the great safeguard of the sane in their dealings with maniacs. It is well illustrated by the following incident.* Sir Walter Scott had reproved Henry Weber his protégé and amanuensis, for indulging in habits of intoxication, which injured his health and interfered with his literary

* Lockhart's 'Life of Sir Walter Scott.'

pursuits. One evening, Scott observed Weber's eye fixed upon him with an unusual solemnity of expression. On inquiring after his health, Weber rose and said: "Mr. Scott, you have long insulted me, and I can bear it no longer. I have brought a pair of pistols with me, and must insist on your taking one of them instantly." With that he produced the weapons from under his chair, and laid one of them on Scott's manuscript. "You are mistaken, I think," said Scott, "in your way of setting about this affair—but no matter. It can, however, be no part of your object to annoy Mrs. Scott and the children; therefore, if you please, we will put the pistols into the drawer till after dinner, and then arrange to go out together like gentlemen." Weber answered with equal coolness, "I believe that will be better," and laid the second pistol also on the table. Scott locked them both in his desk, and said; "I am glad you have felt the propriety of what I suggested—let me only request further that nothing may occur while we are at dinner to give my wife any suspicion of what has been passing." Weber again assented, and Scott withdrew to his dressing-room, dispatched a message to one of Weber's intimate companions, and had the maniac secured and placed in confinement.

11. *Maniacs in confinement are often conscious of their state, and know the legal relations in which it places them.*—An intriguing, unruly, vicious madman was detected with a piece of iron, which he had shaped into a dagger and fixed in a handle. When the weapon was taken from him, he became excessively abusive, and had to be placed under restraint. In the fit of fury that followed, he uttered the most revolting imprecations, and exclaimed to the keeper, "*I'll murder you yet; I am a madman, and they cannot hang me for it.*" When Martin set fire to York Minster, the inmates of a neighbouring madhouse discussed the question whether Martin would suffer the extreme penalty of the law. Various opinions were expressed; but one patient, apparently as mad as the rest, exclaimed, "He (Martin) will not be hanged—of course he will escape." "For what reason?" asked several voices. "They cannot hang him," replied the lunatic, "because he is mad—*he is one of ourselves.*" * It is important to understand that this consciousness of their state belongs only to madmen surrounded by madmen in lunatic asylums, or to those who have been under treatment.

The foregoing are some of those leading characters of mania which bear on the decision of medico-legal questions. They serve to throw light on the phenomena of insanity, and to answer some

* Winslow's 'Plea of Insanity in Criminal Cases,' pp. 16, 17.

of the arguments advanced by persons ignorant of the real nature of this strange condition of mind.* To the better informed they may be useful by setting forth more clearly than any general description could do, the contradictions of which the madman is the sport, resulting in a confusion which no sane mind can conceive. A series of delusions, the offspring of some one excited passion or emotion, or one single delusion, the work of fancy, the interpreter of every sensation, the source of every thought, the mainspring of every action; holding every faculty in stern subjection, making the senses its dupes, the reason its advocate, the fancy its sport, the will its slave; now whispering in the ear things unspoken, now painting on the eye things unseen; changing human beings into fiends or angels; converting every sensation into a vision, every sound into articulate speech; the unreal world within in constant conflict with the real world without; understood of no one, yet believing himself to be comprehended by all; punished for the very acts he thinks his tyrants have commanded, controlled in everything he deems it his duty to perform. There is no wish however presumptuous, no fancy however monstrous, no action however absurd, no crime however heinous, that his delusion cannot create, prompt, and justify.

The degree of confusion existing in the mind of the maniac will, of course, vary with the nature and extent of his delusions. When several spring from one excited emotion or passion, such as pride, vanity, or religious veneration, the distraction must be greater than when one single delusion takes possession of the mind.

Legal Relations of Mania.—There is a difference between the effect of mania on civil and criminal acts.

In civil matters, if a man can be shown "to be *non compos mentis,* the law avoids his act, though it cannot be traced to, or connected with, the morbid imagination which constitutes his disease, and which may be extremely partial in its influence on conduct."† But the law, as it relates to testamentary capacity, makes a distinction between the subjects of general mental aberration and those of partial insanity—monomania. In respect of the former, little or no difficulty is experienced; but legal decisions in several cases distinctly recognise the fact, that the latter are considered quite capable of making a will, unless labouring under a delusion which would materially influence their dispositions.

* For a very able exposition of some of the characters of mania, see Abercrombie, 'On the Intellectual Powers,' 9th edition, pp. 315 and 326.

† Erskine, in his defence of Hadfield; also the judgment of Sir James Wilde in the case of Mrs. Thwaites, August, 1867.

In the case of "Banks *v.* Goodfellow,"* in which the question arose whether a delusion not directly calculated to influence the disposition of property should be considered to invalidate the will, Cockburn, C. J., said—"We are of opinion that a jury should be told that the existence of a delusion compatible with the retention of the general powers of the faculties of the mind will not be sufficient to overthrow the will, unless it was calculated to influence the testator in making it." The same principle was affirmed in the recent case of "Smee and others *v.* the Corporation of Brighton." Here the delusion of the testator that he was the son of George the Fourth, was held to have influenced him in leaving the reversion of his property to the Corporation of Brighton, to found a free library there, thus imitating the example of George the Fourth, to whom the town of Brighton owes so much.†

A will, therefore, cannot be overthrown by evidence of a delusion, unless it can be shown that the delusion has had a direct bearing on the testator's bequests.

But in criminal cases it is not enough to prove a man *non compos mentis;* he is liable to punishment for transgressions of the law, unless it can be shown that he is insane according to what the law lays down as the test of insanity.

How difficult it is to invent a test, or frame a standard of moral responsibility which shall satisfy the requirements of an enlightened psychology, and yet not weaken the hands of the law in preventing crime and protecting society will clearly appear in what is presently to be said under the plea of insanity in criminal cases. It is very slowly, and with extreme reluctance, that the law has submitted itself to the teachings of those who have practical experience of the insane.

The Plea of Insanity in Criminal Cases.—This plea may be raised in respect of such grave offences as homicide, arson, and theft; but as in the large majority of instances the crime has been homicide, and the most important legal discussions have arisen out of it, the remarks that follow must be understood to relate primarily to it. It should also be borne in mind that though the plea of insanity may be set up in reference to homicidal acts committed in a maniacal paroxysm, and by persons otherwise rational alleged to be seized with an uncontrollable impulse, the greater number of cases belong to the class of mania with delusion in which the homicidal act has been carefully planned, and deliberately carried into effect.

* Law Rep., vol. v. Q. B., 549.
† See the 'Times,' Dec. 6 and 9, 1872.

Our earliest legal authorities evidently confounded mania with idiocy, for Bracton defines a madman as one who "does not understand what he is doing, and, wanting mind and reason, differs little from brutes;" and this is evidently the opinion of Coke and Hale, who held "that to protect a man from criminal responsibility there must be a *total* deprivation of memory and understanding." Hale, indeed, made a slight step in advance by distinguishing *total* from *partial* insanity (alleging that partial insanity was no excuse in the commission of any capital offence) and suggesting as a measure of responsibility, "that such a person as, labouring under melancholy distempers, hath yet as great understanding as ordinarily a child of fourteen years hath, is such a person as can be guilty of treason and felony." Mr. Justice Tracy, too, in the trial of Arnold, in 1723, for shooting at Lord Onslow, observes: "It is not every kind of frantic humour, or something unaccountable in a man's actions, that points him out to be such a madman as is exempted from punishment: it must be a man that is totally deprived of his understanding and memory, and doth not know what he is doing, no more than an infant, than a brute, or a wild beast: such a one is never the object of punishment."

The trial of Hadfield for shooting at George III., in Drury Lane Theatre, in the first year of this century, gave the death-blow to these narrow and unsound doctrines, and established delusion as the true test of intellectual mania. In conducting the defence, Erskine showed that what the law had styled madness was idiocy—the idiocy *à nativitate vel dementia naturalis* of Lord Hale himself—and that no such madness as that imagined by the older writers had "ever existed in the world." He then succeeded in showing that "delusion, when there is no frenzy or raving madness, is the true character of insanity," but added the very questionable proviso that in order to render the madman irresponsible for crime, it must be shown, that the act in question was the immediate unqualified offspring of the disease.

These new doctrines, though always quoted with approbation, were soon lost sight of, and in place of the test of delusion sprang up that of "right and wrong." Thus, in the case of Bellingham tried at the Old Bailey for the murder of Mr. Perceval, May 15, 1812, Mansfield, C. J., is reported to have told the jury that they must be satisfied, in order to acquit, that the prisoner was incapable of judging between right and wrong, and that at the time of committing the atrocious act with which he stood charged, he did not consider that murder was a crime against the laws of *God and Nature*. In a cas

which occurred only two months later (that of Bowler for shooting Mr. Burrowes), Mr. Justice Le Blanc left it to the jury to determine whether the prisoner, when he committed the offence was incapable of distinguishing between right and wrong, or whether he was under any illusion in respect to the person he shot, which rendered his mind at the time insensible to the nature of the act he was about to commit; since in that case he would not be legally responsible for his conduct. In a still more recent case (Rex *v.* Offord), Lord Lyndhurst told the jury to acquit, if they were satisfied that the prisoner did not consider his act any crime against the laws of *God and Nature*. A similar principle, with slight and unimportant verbal variations, was affirmed in the trial of Oxford for firing at the Queen, and in the case of M'Naughten. This last case led to an able exposition of the law by the Lord Chancellor in the House of Lords, and elicited the opinions of the law lords, and carefully considered answers to certain questions addressed to the judges. This test of right and wrong was insisted on in the most rigid manner by Mr. Justice Brett, at the trial of a man, Blampied, for the murder of a fellow workman (Maidstone Assizes, July, 1875). The evidence of insanity was, however, so strong that the jury, notwithstanding the judges dictum and expressed contempt for medical theories, acquitted the prisoner on the ground of insanity. Shortly after the same judge reaffirmed the same principle, in a trial for murder, at Croydon, but the jury returned a verdict of not guilty, on the ground of insanity, in spite of the adverse summing up of the judge, who told them they must disabuse their minds of the medical notions as to insanity.

In a still more recent case (that of Thomas Humphreys tried at Stafford, before Lord Justice Bramwell, for the murder of his wife), certain views prevailing among leading legal authorities, are clearly set forth. Humphreys had been subject to epilepsy 17 years, and had attempted suicide 12 years before the murder. Having killed his wife, he stabbed himself in several places. The judge in the course of the trial, and in his summing up, gave expression to the following opinions :—That homicidal mania meant a morbid appetite to do wrong; that proved madness would not justify an acquittal. That even if an insane man knew he was committing murder he would be responsible; that the object of the law was "to guard against mischievous propensities, and homicidal impulses;" that he did not believe in uncontrollable impulse at all, and had never heard of such an impulse leading to action, where the means of prevention were present. (This being a case on which such means were

not brought to bear, the remark was utterly irrelevant). The judge then proceeded to state what he would and would not deem good grounds for acquittal. A person would be acquitted who did not know the nature of his act, or, in committing it, did not know he was doing wrong, which meant "what the law forbade," or "did not know he was inflicting hurt," or, that his act was injurious to the person he attacked." This is the mistake of Bracton and the older writers reproduced, to which Erskine's words are peculiarly applicable, that "no such madness had ever existed in the world." His lordship then pointed out the absence of motive, and of ill-will, and the many circumstances which warranted the conclusion that Humphreys was insane; and ended by directing the jury to acquit, which the jury did without quitting the box.*

The state of the law up to a recent date, and, indeed, up to the present time, may be inferred from the answers of the fifteen judges to the questions suggested by the trial of M'Naughten, and submitted to them by the House of Lords—answers in which the whole bench, with the exception of Mr. Justice Maule concurred. They were read to the House by Lord Chief Justice Tindal, on the 19th June, 1843. They are given *in extenso* in former editions of this work, but here it must suffice to state the general result to which they lead:—That before the plea of insanity can be allowed, it must be proved in evidence that the accused was of diseased mind, and that at the time of committing the act he was not conscious of right and wrong; that though delusion be taken as the test of insanity, the knowledge of right and wrong is taken as the criterion of responsibility: and that an individual who is only partially insane is equally responsible for a crime as a person of sane mind. In so far as the act would be excused in a sane person, as, for instance, homicide in self-defence, the monomaniac would be excused, but not if the act were committed in revenge for some supposed injury.

The principles thus laid down are open to the following obvious objections:—1. To make delusion the sole legal test of insanity in criminal cases, and especially in cases of homicide, is completely at variance with the well-ascertained facts of impulsive insanity, in which the existence of delusion can be distinctly negatived, as well as in many forms of emotional insanity, in which delusions form no necessary feature of the disease.

2. On the other hand, the test of a knowledge of right and wrong is condemned by the notorious fact, that a great many insane patients, and even imbeciles (see the case of A. H. p. 190)

* 'Times,' November 6, 1878.

have a clear appreciation of the two ideas. Indeed, the whole management of asylums presupposes a knowledge of right and wrong on the part of the inmates.

3. Nothing can be more illogical than the statement of the law, in reference to the partially insane. It amounts to nothing less than an absolute denial of the significance of a state of things universally acknowledged to constitute a valid test of insanity. The error has arisen from confounding single and harmless delusions, such as occur in most cases of hypochondriasis, with those that afflict the insane commonly so called. Such single delusions are doubtless more compatible with self-restraint; but they are of rare occurrence, and do not often figure in courts of law, and, harmless as they may seem to be, and as those of Buranelli apparently were, we cannot safely assume that they may not take a dangerous turn. That a man should believe that he is the Crystal Palace, may seem a very harmless fancy; but, if he grew angry with the Government for removing it, to assassinate some member of the Government, would be far less illogical than the fancy itself.

The *partial delusions* of the *insane* are much more common, but when they are closely examined they are found to be the offspring and natural expression of some one excited feeling or passion, which, having had force enough to create illusions of the senses and delusions of the mind, may be expected to give rise to insane impulses of great power: to which we may add that a multitude of delusions implies mental confusion and excitement in proportion, and that in many instances these conditions are heightened by the co-existence with these delusions of the mind, of illusions of the senses, and illusive transformations of real objects and persons. (See supra, p. 211.)

The excited feelings or passions which, having first destroyed the integrity of the senses and mental faculties, proceed to instigate acts of violence and cruelty, are religious excitement or despondency; jealousy; domestic anxieties exaggerated into fear of starvation; and discontent transformed into an insane belief in persecution. Now the acts of violence which ultimately flow from these excited feelings or passions, the true sources of delusion, ought to be judged by the same rules that apply to the delusions themselves. It is reasonable and logical to infer that the acts are as little subject to restraint as the delusions to correction. What right have we to assume that the man who cannot control his thoughts, is master of his actions?

We will consider these four sources of homicidal acts separately.

1. Maniacs under the influence of religious excitement or de-

spondency are subject to illusions and delusions of a very singular kind. They transform the persons with whom they are associated into supernatural beings, endowed with authority or power not to be questioned or resisted; and they convert common and familiar sounds into the articulate language of temptation or command. One religious maniac, therefore, kills a relative or a keeper, imagining him to be a fiend; another thinks that he has a direct commission from the Deity to fulfil some mission of wrath or extirpation. In cases of religious mania, then, we can never safely affirm that the homicidal act was not the natural consequence of a command which the maniac would deem it impious to resist, or of a delusion which places him in his own sincere conviction beyond and above the operation of human laws. The maniac who believes himself to be God, Christ, or the Holy Ghost, would, from the very nature of the case, deem himself irresponsible.

2. Of homicidal acts instigated by jealousy shaping itself into a distinct delusion, it will suffice to observe that they are such acts as if committed by sane men on the evidence of their senses would be punished as manslaughter, and not as murder.

3. Of the fathers and mothers who kill their children under the pressure of domestic anxiety culminating in an insane dread of starvation, it may be observed that they are generally remarkable for domestic virtue and devoted attachment to their victims, and that between them and ordinary murderers there is no single point of resemblance.

4. Discontent, transformed into an insane belief in persecution, presents greater difficulties. The case is generally put in a form which seems to preclude a satisfactory answer. A maniac thinks he has been injured by another, and he kills him. If the injury were real, a sane murderer would be responsible, and so, it is contended, ought the madman to be. This curiously illogical argument ignores the simple fact that the two cases have nothing in common but the act itself. The imaginary offence has imaginary accompaniments, and every thought connected with it is one of confusion. To suppose that a mind which can imagine an impossible offence is sound in all other respects is to outrage common sense, and set at nought the experience of all who have knowledge of the insane. For with one consent they repudiate the notion of a mind subject to such a delusion being sound, and free to act as it will, beyond the sphere of its influence. The more closely the victim of this partial delusion is observed, the more extensive is found to be the disorder of his intellect. Those acts which are not directly prompted by his delusion are more

strange, and his passions more excitable than those of other men. The theory of a single insane idea, springing up in a mind otherwise sound, having no effect on the remaining faculties, and simply prompting an action which, once suggested, is carried out with the same complete consciousness of its real nature as exists in the mind of a sane man acting under the suggestion of a corresponding reality, is too absurd to be for a moment entertained. Even in this case, then, the question of responsibility cannot be decided by the simple test of a knowledge of right and wrong.

But there is another case allied to the one now under consideration which presents still greater difficulties. A man receives a real injury, and avenges himself; but it is alleged that he was not of sound mind when he committed the act. The unsoundness of his mind is admitted, but he is deemed responsible because his act was instigated by the common motive of revenge. The obvious answer is, that the real injury has been by his insane mind magnified to undue importance, and then acted upon just as if it had been altogether imaginary; and that he is therefore neither more nor less responsible for his act than the man whose motive was from the very first in the nature of a delusion. In this case, too, an inquiry into the state of the mind, extending much beyond the legal test, will be necessary, and cannot be refused; and this, once granted, must result in showing the insufficiency of the test. Even in those cases where the criminal act cannot be traced to any delusion of which it is the legitimate offspring, but it is simply alleged in defence that the party is of unsound mind, the very fact of the unsoundness becomes an irresistible plea in mitigation. It would be strange indeed if the case of the maniac under the accusation of crime, is the only one in which such a plea is ignored and refused.

Here it is natural for us to inquire what the able lawyers who have drafted the new Criminal Code Bill, have laid down as the law on this important subject. On turning to Section 22, of the proposed code, we find nothing new except the proviso that insanity preceding or following the offence, and insane delusions, though partial, may be received as evidence of a condition of mind entitling the accused to acquittal on the ground of insanity. We give the section entire in a foot note.*

* SECTION 22 (p. 67).

Insanity.

"If it be proved that a person who has committed an offence was at the time he committed the offence insane so as not to be responsible for that offence, he shall not therefore be simply acquitted, but shall be found not guilty on the ground of insanity.

"To establish a defence on the ground of insanity, it must be proved that

We cannot, therefore, too strongly condemn the credulity which credits a mind already occupied by delusions with an otherwise efficient state of its faculties; and we contend that it is in the highest degree improbable that a mind so possessed can, beyond the sphere of its delusions, think, feel, and act with the clearness, force, and freedom of the sane.

Some writers, under a strong sense of the failure of the legal test of a knowledge of right and wrong, have sought to set up in its place the power of control or restraint. The test has been thus transferred from the intellect to the will—from the knowledge of right to the power of acting aright. But this is a mere shifting of the difficulty; for it is obviously not more easy to measure the exact amount of a man's self-restraint than to gauge his abstract knowledge of right and wrong, lawful and unlawful.

the offender was at the time when he committed the act labouring under natural imbecility or disease of, or affecting, the mind, to such an extent as to be incapable of appreciating the nature and quality of the act or that the act was wrong.

"A person labouring under specific delusions, but in other respects sane, shall not be acquitted on the ground of insanity unless the delusions caused him to believe in the existence of some state of things which, if it existed, would justify or excuse his act. Provided that insanity before or after the time when he committed the act, and insane delusions, though only partial, may be evidence that the offender was at the time when he committed the act in such a condition of mind as to entitle him to be acquitted on the ground of insanity.

"Every one committing an offence shall be presumed to be sane until the contrary is proved."

On this section of the proposed code, Cockburn, C. J.,* comments at considerable length, and, for the most part adversely. He finds fault with the authors of the code for not distinctly recognising the words "contrary to law," used by the fifteen judges, in reference to the M'Naughten case, and which in his (the Chief Justice's) judgment meant, and ought to mean, *legally* wrong; for not recognising "homicidal mania," the existence of which he himself does not dispute; for so using the phrase, "nature and quality of the act," and the word "wrong," that he (the Chief Justice) cannot divine their meaning: and for making a distinction between "specific" and "partial" delusions which he fails to appreciate. He also blames them for including imbecility under insanity—an interpretation which their words do not warrant.

It is impossible not to recognise in the passages thus imperfectly summarised, the working of a mind that has welcomed the teachings of science, which other eminent lawyers so studiously reject; and who does not sympathise with them in the disrespect with which they treat the members of a profession that monopolises the care and treatment of the insane, and therefore possesses unique opportunities for studying, and, as far as that is possible, understanding the unsound mind.

* Copy "of Letter from the Lord Chief Justice of England, dated the 12th day of June, 1879, containing comments and suggestions in relation to the Criminal Code (Indictable Offences) Bill," printed by order of the House of Commons (232).

Mr. Balfour Browne ("Responsibility and Disease"), after citing the words of the fifteen judges "that before a plea of insanity should be allowed, undoubted evidence ought to be adduced that the accused was of diseased mind, and that *at the time* he committed the act he was not conscious of right and wrong," argues with much show of justice that it is not a speculative knowledge of right and wrong which the law contemplates, but the "active idea of right and wrong which a man has when thought is passing over into action." But inasmuch as we cannot know the exact state of mind which prevails at the time of committing the act, such interpretations as these cannot help us much.

The homicidal acts which men commit under the influence of delusions have antecedents which occasion much perplexity, especially in the minds of lawyers and others who have little or no experience of the insane. The homicide watches his opportunity, bides his time, prepares a fitting instrument, and uses it in the ordinary way, whether he be an inmate of an asylum or not (see case at p. 214), and it is natural to infer that he possessed such an amount of self-control as ought to have prevented the murderous act. But the answer is obvious. It is drawn from the analogy of the madman's sensations and thoughts. If he could not prevent the senses from being the sport of illusions, and was unable to root out delusions from his mind, how can he be expected to control the irregular impulses and passions which are to the will what illusions are to the senses or delusions to the intellect? And if it be alleged that the skill evinced in planning the homicidal act, and the patience shown in waiting for a favourable opportunity, ought to be taken as evidence of adequate self-control, appeal may again be made to analogy. The acts of the maniac are in strict keeping with his thoughts. His delusions, even when they are most distinctly present to his mind, are quite compatible with the exercise of all his faculties—of the reasoning faculties, and of the will. If they are attacked, he defends them acutely, and justifies them plausibly; and under the influence of a strong motive, he has strength of purpose enough to conceal them. They have not destroyed his faculties, they have merely perverted them to a wrong use. So is it with his homicidal act. The impulse which seizes upon his unsound mind does not destroy its powers, it merely perverts them.

Accordingly, if a maniac is under the delusion that his keeper is a fiend, or if he believes that the Deity has commissioned him to take away his life, he will secrete and sharpen a knife, watch his opportunity, and act in every respect as a sane criminal would do;

and, if prevented, he will wait for a more favourable occasion. Nay, the merest imbecile knows that a heavy stick, a knife, or a pistol is a common instrument of death; and weak as his mind may be, he conceals it, not because he is conscious of guilt, but because he knows that, if it were openly displayed, the action he contemplates would be prevented, and if, as in the case cited at p. 190, an imbecile is bent on killing some one, he selects a victim who is unable to resist him.

The fact is, that in proposing this test, as in the general discussion of this question, two distinct things have been confounded —the act itself, which is the result of the delusion, and the mode of accomplishing it. It is the delusion which distinguishes the madman, and not the manner of the homicidal act, just as it is the delusion which betrays his unsoundness, not the reasoning by which he defends and justifies it.

The difficulty of devising a test which shall not be open to the most serious objections, has led some persons to invent an easy method of escape, by depriving persons of unsound mind of what they call the privilege of insanity, or, in other words, refusing to entertain the question of the state of the mind at all. This suggestion may have the merit of simplicity, but it is open to the serious objection that it could be acted upon only once. The spectacle of an imbecile or a maniac on the scaffold would be simply intolerable. No jury could be found to convict: and the indiscriminating statute would prove as complete a dead letter as the statute which awards the punishment of flogging to assaults upon the Queen did, when the question arose of applying it to the person of the poor imbecile Lieutenant Pate. The idea of hanging and flogging madmen is utterly repulsive, and must be given up.

Another theory propounded by some writers of eminence, is that as madmen are, like other men, influenced by fear, the punishment of death as the consequence of murder should be kept before their eyes. This theory may be said to have broken down in the case of Lieutenant Pate, just referred to. It is most improbable that this poor imbecile was ignorant of the degrading punishment awarded by a recent statute to persons who assault the sovereign; but the threat had no effect upon him. By parity of reasoning, the threatened punishment of death ought to prove equally ineffectual in all madmen. But, in reality, the deterring influence of the death punishment is already brought to bear; for the insane who have not been certified, and lodged in lunatic asylums, do not believe themselves to be mad; they are, in their own sight, sane men. It is only after they have been thus taught, that the terror of the gallows is brought to bear.

The advocates of this theory defend it by comparing persons of unsound mind with the lower animals, alleging that, as dogs can be weaned by punishment from practices distasteful to their masters, so madmen can be deterred from crime by fear of death. In putting forward this analogy two facts are overlooked—the fact that the animal has been punished, and has a distinct recollection of the pain inflicted upon him, while the madman has been merely threatened; and the fact that many dogs cannot be weaned from bad habits by the frequent repetition of the most severe chastisement.

It is well to add, that if we assume the madman to be attentive to, and cognizant of, what is being said and done by the public, he must know that a verdict of acquittal, on the ground of insanity, entails confinement for life, which, as a punishment, is not second in severity even to death itself.

Nor is there any reason to fear that, by exempting the madman from the punishment of death, we shall weaken the hold the law has on the man of sound mind; for in order that he may escape death, he must successfully feign insanity—a task of no ordinary difficulty—and, if he succeed, a perpetual sacrifice of liberty awaits him. Society would, on the one hand, suffer no injury if no madmen were hanged, and it would gain something by openly attributing to disease some of the most revolting acts that degrade and debase our common nature.

There are some persons who view the admission of the plea of insanity, and the consequent acquittal of notorious homicides, with aversion as tending to the encouragement of crime. To such persons the results of an inquiry which I instituted more than ten years ago* will furnish a consolatory answer. The results are briefly as follows:—"On testing the trials which have excited most public interest, and led to most discussion," namely, those of M'Naughten, Dadd, and Martha Brixey, of Oxford, and the equally notorious, though different cases of Francis and Lieutenant Pate, "by the figures which represent either insane homicides or sane murderers in the year or years immediately following, there are no signs of encouragement when the penalty of death is not inflicted, or of discouragement when it is:—that, on the contrary, the figures would seem to justify the inference that neither to the sane nor to the insane class among our criminals does the prospect of long imprisonment, or detention for life in a lunatic asylum, offer any attraction or temptation; while the punishment of death

* "On Insanity and Crime; and on the Plea of Insanity in Criminal Cases," By William A. Guy, M.B., F.R.S., &c. &c.: 'Journal of the Statistical Society,' vol. xxxii. p. 159 (April, 1869).

(perhaps only as formerly inflicted) seems as if it might have exercised a certain attraction or fascination."

In respect to the responsibility of madmen, then, the law is in this dilemma;—it must either insist on a test which it is impossible to apply, or it must uniformly refuse to admit the plea of insanity. If it hold to a test, its decisions will want that uniformity which ought to belong to them, and their soundness will be constantly called in question; if it reject the plea of insanity, it ought forthwith to do away with all other pleas in mitigation.

In the case, then, of the class of maniacs now under consideration, who, being subject to delusion, commit their acts of violence with premeditation, it is submitted that all tests are inapplicable and useless; that the law of England ought to be assimilated to that of France—"Il n'y a ni crime ni delit lorsque le prévenu était en état de démence au temps de l'action."

The foregoing observations apply to cases of insanity commonly so called, and not to that form of madness which consists in uncontrollable impulse.

This form of unsoundness is now generally recognised by medical men as *instinctive* or *impulsive* mania, and has on more than one occasion led to the acquittal of an accused party.

The acts committed under its influence have most or all of the following characters: They are without discoverable motive, or in opposition to all known motives. A man kills his wife, to whom he is tenderly attached; a brother his sister; a mother her infant; or the victim is one whom he never saw before, and against whom it is impossible that he can bear malice. Nay, the victim of this blind passion may be a horse or other animal incapable of offence.* After the commission of the act, he does not seek to escape; he often publishes what he has done; does not conceal the body, but openly exposes it; delivers himself up to justice; describes the state of mind which led to the act, and either remains stupid and indifferent, or is overwhelmed by remorse. He has no accomplices, has made no preparations, and takes nothing from his victim. Sometimes he has previously spoken of his strong temptation, and begged to be prevented from doing mischief. These homicidal acts are generally preceded by a striking change of conduct and character, and, on inquiry, the accused is often found to have an hereditary tendency to insanity.

* This statement is justified by the following case cited in a leading article of the 'Times,' December 9, 1879. "A gentleman of fortune, who was subject to delusions of exaltation, suddenly produced a hatchet from under the seat of the carriage he was driving, and made a furious attack upon an unoffending cab-horse which was standing peacefully on a rank."

to be subject to fits, to have attempted suicide, to have expressed a wish for death, or to be executed as a criminal.

It is to such cases as these that the words of Lord Hale are peculiarly applicable: "lest, on the one side, there be a kind of inhumanity towards the defects of human nature, or, on the other side, too great an indulgence given to great crimes." Imbeciles are peculiarly liable, as we should suppose they would be, to these wild impulses; and it is easy to understand how the instinct of destruction is sometimes associated with delusions, the criminal act itself being the result of strong excitement of the homicidal passion, while the delusions suggest the motive. To this class probably belong those cases of wholesale murder in which the father of a family destroys his wife and children, to prevent them falling victims of starvation, and then puts an end to his own life; the idea that such an evil threatens them being insane, no less than the impulse which prompts such a mode of escape.

Some imbeciles who are addicted to petty theft, rob their victims; but they make so childish a use of that which they have stolen as to afford fresh proof of their inherent weakness of mind.

Violent homicidal impulses are also very common in the *epileptic*, sometimes preceding, sometimes following, the fits, and sometimes taking their place (*masked epilepsy*). The following cases are instructive:—

A shoemaker, subject to epilepsy, was often furious for some time after the fits, but sensible, amiable, and industrious in the intervals. One day, when in the gloomy and morose state of mind that often precedes a fit, he met the superintendent of the ayslum, to whom he was much attached, and stabbed him to the heart. He had not had a fit for three weeks, but the night following the homicide he had a bad fit, and for some time the attacks continued to be frequent and severe.

A peasant suffered from epilepsy from his eighth to his twenty-fifth year, when, instead of epileptic attacks, he was seized with an irresistible impulse to kill. He felt the approach of his attack sometimes for days beforehand, and begged to be restrained. "When it seizes me," he said, "I must kill some one, were it only a child." Before the attack he was very weary and depressed, could not sleep, and had slight convulsions of the limbs.*

To complete this inquiry into the plea of insanity in criminal cases, the following sketch of the different aspects given to homicidal acts by the several varieties of unsound mind is submitted:—An imbecile has a confused and imperfect notion of

* Quoted from Marc by Maudsley ('Physiology and Pathology of the Mind,' p. 309).

crimes, laws, and punishments; and his acts are as foolish as his thoughts. The case referred to at p. 189 is a good example of this class. A monomaniac fancies himself an object of persecution, and kills one of his imaginary tormentors, hoping thereby to rid himself of all; an act as mad as the thought which inspired it. Such was M'Naughten. Another, having betrayed decided symptoms of madness, receives a real injury and kills the offender. Such was Lord Ferrers. A third, oppressed with melancholy fears, kills those to whom he is most attached, to save them from an imaginary fate. Such was the female already referred to, who, under the fear of starvation arising out of temporary difficulties, killed her child, cooked it, ate of it, and offered the dish to her husband. Lastly, we have the so-called instinctive madness, to which the case of William Brown, given at length in Ray's 'Medical Jurisprudence of Insanity,' affords a good example; as also the case of A. H. cited at p. 190.

V. FEIGNED UNSOUNDNESS OF MIND.

Men feign insanity from the same motives which lead them to simulate other diseases, and it is specially true of this class, that it is only by actual experience of the real disease that, in difficult cases, the counterfeit can be detected.

Idiocy.—This is rarely assumed, and, when feigned, is easy of detection. The idiot has almost always the defective formation of head, face, and person pointed out at p. 183; and it must always be practicable to learn so much of an impostor's history as that he was not always in the condition he has assumed.

Imbecility.—In this case, too, the history, where it can be obtained, will assist in unmasking the impostor. The peculiar cast of countenance of the imbecile is not easy to imitate; the vacant, wandering look, the unsettled, uneasy manner, the disconnected and evanescent ideas, the variable temper and spirits, the sudden and transient gusts of passion, and the foolish and childish acts, are, collectively, very difficult to assume.

In the less strongly-marked forms of real imbecility, folly and acuteness are displayed indifferently on all subjects; but the impostor is shrewd on those which involve his interest or the success of his scheme, and displays his stupidity only in matters of indifference. These cases present unusual difficulty, and give rise to great differences of opinion. We have had under our notice several imbeciles certified as insane by the medical officers of prisons, and returned from the asylums as impostors; and others in which, after long and careful observation under most favour-

able circumstances, two equally competent observers have not been able to agree in their opinion. Unsettled habits, wandering and disconnected thoughts, sudden bursts of passion, unprovoked acts of violence, unsuccessful attempts at suicide, transient and half-formed delusions, short fits of industry, handiwork displaying much skill and ingenuity, make up a combination which it is in the power of a good actor to assume. But imbeciles of this order possess sufficient shrewdness and self-control to conceal and moderate their eccentricities when they have an object to accomplish. So that it is quite possible for a real imbecile in prison to seem an impostor in an asylum. Nor must it be forgotten that the previous lives of these people have been one continuous history of deception, and of shifty devices for living without work (G.).

Dementia.—This is rarely imitated, that torpor of all the faculties which belongs to the true disease being hard to assume and sustain ; and we may be assisted in our diagnosis by discovering marks of the paralysis which attends one form of chronic dementia. Our chief difficulty in diagnosis may arise out of the rare obstinacy with which a prisoner—a female especially—will maintain a weak expression of countenance, repeat a few silly phrases, pass the excreta as if involuntarily, and resist every test that it is possible to apply. Such a malingerer may never have deceived the medical observer for a moment; but he may be compelled to wait patiently for a confession of the fraud.

Mania.—As it is more easy to assume the violence of mania than the more subdued characters of the foregoing forms of unsoundness, mania is more frequently feigned. The distinction between the fictitious and the true disease, though occasionally a work of time and patient observation, is not difficult.

The intense expression of countenance, the wildness of eye, and the marked alteration of feature of real mania, are very hard to assume and maintain. The violent excitement, the loud shouts, the incoherent speech, the strong struggles and convulsive movements of the paroxysms, also scarcely admit of imitation, and cannot be supported for any length of time. The real maniac will continue without sleep for days, and even weeks, or if he sleep at all, his rest will be disturbed and agitated; but the impostor can scarcely keep awake beyond one or two days, and a dose of opium, or an injection of morphia, which would produce no effect on him, would infallibly send the impostor to sleep. The same remark applies to other remedies, such as emetics and purgatives. The madman will also go without food for days together with impunity, and little loss of strength ; and is so in

sensible to external impressions that he will bear the most intense heat or cold, and gaze, without being dazzled, on the strong light of the sun. Other symptoms of less importance have been insisted on, such as the torpid state of the bowels, the moderate or low temperature of the trunk and limbs, a peculiar odour of the skin, and a frequent pulse.*

To this account of the physical signs of mania, it may be added that the impostor will overact his part during such times as he is watched; that instead of becoming more quiet and reserved on the approach of the physician, his violence increases; that he assumes a want of intelligence instead of that perversion of reason so characteristic of the real affection; that he obtrudes instead of concealing his thoughts; that he pretends a defect of memory and apprehension which does not belong to real insanity; gives false answers to questions, and affects not to recognise persons whom he knows; that he does not recur constantly to the leading idea; that he betrays hesitation in the midst of his assumed violence; that he has not the steady gaze of the madman; that his fits occur suddenly and at irregular and convenient intervals, instead of having the periodicity of intermittent attacks of mania. It may be added, that instead of having a period of incubation so general in true mania, the first attack of his disorder is sudden. That perversion of the moral feelings which causes the madman to dislike every person to whom he was previously attached, being a symptom little known to the vulgar, is not assumed by the impostor. Besides the diagnostic marks to be gleaned from the foregoing description, and the precautions already mentioned under the head of feigned diseases, some special tests have been recommended, such as repeating to the suspected person a series of ideas recently uttered, when the real maniac will introduce new ideas, but the impostor will repeat the words. The use of the whirling chair has also been recommended, as producing giddiness and nausea in the impostor.

Partial Intellectual Mania.—Monomania, Melancholia.—These partial forms are less frequently feigned than general mania, or raving incoherence, and rarely with success. Many of the characters of mania already described are present in cases of intellectual mania springing out of some excited emotion, such as pride or vanity. There is the same irritability of temper, the same violent prejudices, the same unfounded aversions and equally

* In the first edition of this work facts were adduced to show that the value of the pulse as a diagnostic mark had been exaggerated. All, perhaps, that can be safely affirmed is that an infrequent pulse, which often exists in healthy persons, could scarcely exist in the paroxysms of mania.

unfounded attachments, the same sleeplessness, the same insensibility to impressions, and to the operation of medicines. The pretended monomaniac makes an open display of his assumed delusion, while the real monomaniac rarely solicits attention. The true monomaniac is generally reserved, taciturn, and indifferent, but is easily excited and angered by opposition and argument. When hard pressed, men generally take refuge in violence, and women in tears.

The forms of intellectual insanity most commonly assumed and most difficult to distinguish, are those which consist in the assumption of a single delusion, or of profound melancholy; and it is obviously difficult to lay down any diagnostic marks by which the real disease can be distinguished from the false; and the difficulty of diagnosis is seriously enhanced when, as sometimes happens, the malingerer is a good actor, and makes a faithful copy of the words and acts of a madman with whom he has been brought in contact in or out of an asylum.

Moral Mania, General and Partial.—General moral insanity, consisting of a strange combination of foolish, obscene, and cruel acts, may have to be distinguished from mere wickedness: but it is not apt to be assumed. To distinguish moral insanity from vice must needs be difficult; but, as a general rule, there is a strangeness and variety in the acts of the madman which do not belong to those of the sane criminal. For partial moral mania the only possible test is the absence of motive for the commission of the acts in which the mania consists; and in certain cases the grief or horror with which the insane acts are regarded. A man of independent means and respectable position in society who steals every object within reach, is to be considered of unsound mind as far as that propensity is concerned, however clear the intellect or free from fault the remainder of his acts; and so of a woman who indulges passions against which every feeling of modesty and propriety rebels.

Concealed Insanity.—The power of concealing his delusions, under the influence of some strong motive, has already been shown to belong to the madman; and long-continued observation, repeated interrogations, and careful inquiry into the patient's previous history, may be necessary to bring the delusions to light.

It ought also to be understood that madmen, whether subject to illusions or delusions, or to both, are often very reticent on the subject of the motives which really influence them. Sir Benjamin Brodie (in a note appended to the first volume of his "Psychological Inquiries") quotes from Esquirol the case of a young man who, after some disappointment, fell into what seemed a state of idiocy.

"His eyes were fixed; his physiognomy without expression. It was necessary to dress and undress him, and to put him to bed. He never ate, except when food was put into his mouth. He never walked except when compelled to do so. He recovered after the use of some remedies, and the appearance of an eruption on his skin. After his recovery he confessed that he had never been insensible at all, but that an internal voice was always repeating to him '*Ne bouge pas! ne bouge pas!*' and that fear alone had rendered him immovable."

VI. RULES FOR THE EXAMINATION OF PERSONS SUPPOSED TO BE OF UNSOUND MIND.

The main points to be attended to in the several examinations which the medical man may be required to institute, are the following:—

1. Observe narrowly the general appearance, conformation, and shape of the head; the complexion and expression of the countenance; the gait and movements, and the speech.

2. Ascertain the state of the health, of the appetite, and digestion, of the bowels, of the tongue, skin and pulse. Note especially the presence or absence of febrile symptoms, as distinguishing delirium from madness. Ascertain whether there is sadness or excitement, restlessness or stillness, and whether the sleep is sound and continuous, or disturbed and broken. In females, inquire into the state of the menstrual function.

3. The *family history* should be traced out, in order to ascertain whether there is any hereditary predisposition to insanity, and whether other members of the family have been subject to fits, or have betrayed marked eccentricity of behaviour.

4. The *personal history* should be ascertained with equal care. If the mind appear unsound, ascertain whether the unsoundness dates from birth, from infancy, or from what time. If the unsoundness have supervened later in life, whether it followed severe bodily illness, accident, mental shock, long-continued anxiety of mind, repeated epileptic fits, or indulgence in habits of intemperance, or in solitary vice.

5. Inquire whether the present state of mind differs from that which existed when it was reputed to be sound; and whether the feelings, affections, and domestic habits have undergone a change.

6. Ascertain whether the existing unsoundness is a first attack, and if so, whether it began with depression or excitement; if not, did the first seizure follow a period of melancholy, passing into mania, and then into slow convalescence? If any signs of

general paralysis are present in the speech or gait, has the patient squandered his money, grown restless, and wandered about, exposed his person, committed petty thefts, or had delusions of wealth or grandeur?

7. When our object is to ascertain the mental capacity, it must be tested by conversation directed to such matters as age, the birth-place, profession, or occupation of parents, number of brothers, sisters, and near relations, common events, remote and recent, the year, name of the month, and day of the week, the name and family of the sovereign, and of persons best known and most talked of. The power of performing simple operations of arithmetic, and the knowledge of the value of money should be tested, and the memory by repeating simple forms of words in general use, such as the Lord's Prayer. In testing the power of attention, merely negative or affirmative answers to leading questions should be distinguished from such replies as indicate judgment and reflection. If the inquiry relate not to the capacity of the mind, but to its soundness in other respects, delusions should be sought for by conversations directed to the topics most likely to interest and excite the mind. The state of the moral feelings will be tested by conversation directed to relatives and friends. In cases of supposed moral insanity, diligent inquiry should be made into the motives which might have led to the commission of the act of which the party is accused.

8. The medical man should insist on full opportunity being given him of forming his opinion. He should rarely be content with a single visit; and in difficult cases, should require that the party be placed for some time under his observation.

9. When undergoing examination in a court of law, the medical witness is recommended to avoid all definitions of insanity, on the plea that mental, like bodily diseases, do not admit of definition, but, in common with many familiar objects, can be recognised though not described.

10. In signing certificates of lunacy, the medical man should bear in mind that he is required to see the patient by himself, to sign the certificate at the time of the visit, and to assign the reasons which have influenced him in attaching his signature to it.

To the foregoing directions a few practical suggestions and hints may be added with advantage relating to the two important and responsible duties of the medical man—imposing restraint and signing certificates.

Restraint.—The medical man, in the exercise of his profession, may be called to a patient suffering from fever, delirium tremens, or mania, and may find him in a state of excitement dangerous

to himself and to those about him. It seems as natural to him to order the patient to be restrained as to prescribe medicine for him. If he were not to do so, and the patient were to destroy himself or others, he would expose himself to the indignant censure of the whole community. But if in the exercise of his discretion he makes arrangements for restraining the patient, and the patient, on recovery, real or apparent, pleases to sue him for damages, he may inflict upon him the annoyance, loss of time, and expense of a trial by jury.* This risk, it appears, cannot be avoided; but it may be reduced by the medical man observing the precaution of obtaining a written authority from the nearest relative in attendance on the patient—from husband or wife, father or mother, brother or sister, as the case may be, and a guarantee against the expense of an action for false imprisonment, cruel treatment, or imperfect observance of legal requirements, which a man who has been rightly or wrongly released from confinement has it in his power to bring.

Certificates.—In the case of paupers one medical certificate only is required, with an order signed by a justice of the peace, or, in his absence, by the relieving officer or overseer and the officiating clergyman of the parish in which the lunatic is at the time. In all other cases the certificates of two medical practitioners and the formal demand of a relation or friend. These certificates, to be valid, must be signed by legally qualified practitioners, having no interest, direct or indirect, in the patient, or in the establishment to which he is to be sent; they must bear the exact address of the patient, and the date of the examination and signature; the visit must be a separate visit (each medical man examining the patient separately); and the certificate must set forth distinctly the grounds of the opinion, under the distinct heads of facts observed by himself, and facts communicated by others (such others to be specified), and be signed with name, address, and date. It remains valid only for seven days. If defective it may be amended.

A proper printed form in accordance with the statutes regulating the custody and treatment of the insane, and containing plain marginal directions, may be obtained of the law stationers. It comprises a "Notice of Admission," to be signed by the

* See the case of Nowell *v.* Williams ('Times,' Nov. 14, 1879), tried before Lord Coleridge and a special jury, as a good example of the expense and annoyance that such legal proceedings inflict on persons who innocently think themselves in the path of duty. Heavy expense, and the torture of a fifteen days' trial, are inflicted on a gentleman who defends his own sister, by legal means, against her jealous husband, armed with a revolver, and the subject of most dangerous delusions.

superintendent or proprietor of the asylum, to be forwarded to the Commissioners of Lunacy within one clear day from the patient's reception; an "order for the reception of a private patient" addressed to the proprietor or superintendent of the establishment, and signed by a person who specifies his "degree of relationship (if any);" with a "statement" containing a detailed account of the patient and his history; and, lastly, two identical forms of "Medical Certificate," of which we append a copy (p. 238).*

Provision is made for the protection of insane persons wandering abroad without proper care by 16 and 17 Vict., secs. 67, 68, and 70, which inflict a fine of 10*l.* on medical officers of parishes, as well as on overseers or relieving officers, who, having knowledge, in any way obtained, that a lunatic is "wandering at large," or not "under proper care and control," or "cruelly treated or neglected," does not take measures to bring the case before a magistrate. Additional protection is afforded to the insane person and to the public by sec. 68 of this Act, which makes it "lawful for any justice, upon its being made to appear to him by the information upon oath of any person whomsoever that any person wandering at large within the limits of his jurisdiction is deemed to be a lunatic, by an order under the hand and seal of such justice, to require any constable of the parish or place, or relieving officer or overseer of the parish where such person may be found, to apprehend him and bring him before such justice,"† &c.

* Lord Coleridge, in the case of Nowell *v.* Williams, strongly condemned the present practice of having both medical certificates on the same paper.

† The reader will find much valuable information on the legal relations of insanity, and on the duties of medical men in charge of asylums, as well as on the whole subject of unsoundness of mind, in Dr. Sankey's 'Lectures on Mental Disease,' 1866, and in the 'Handbook of Law and Lunacy,' by Dr. Sabben and J. H. Balfour Browne, 1872. Those who are directly interested in the care and custody of the insane should consult 16 and 17 Vict. cap. 96 and 97, also 8 and 9 Vict. cap. 100.

MEDICAL CERTIFICATE.—Sched. (A.) No. 2, Sects. 4, 5, 8, 10, 11, 12, 13.

I, the undersigned,
being a (a)

and being in actual practice as a (b)
hereby certify, that I, on the Day of
at (c)
in the County of separately from any other Medical Practitioner
personally examined
of (d) and that
the said
is a (e) and a proper person to be taken charge of and detained under Care and Treatment, and that I have formed this opinion upon the following grounds; viz. :—

1. Facts indicating Insanity observed by myself (f)

2. Other facts (if any) indicating Insanity communicated to me by others (g)

Signed, *Name*, ______________________

Place of Abode, ______________________

Dated this Day of One Thousand Eight Hundred and Eighty

(a) *Here set forth the qualification entitling the person certifying to practise as a physician, surgeon, or apothecary, ex. gra.:*—Fellow of the Royal College of Physicians in London, Licentiate of the Apothecaries' Company, *or as the case may be.*

(b) Physician, surgeon, *or* apothecary, *as the case may be.*

(c) *Here insert the street and number of the house (if any), or other like particulars.*

(d) *Insert residence and profession, or occupation (if any) of the patient.*

(e) Lunatic, *or* an idiot, *or* a person of unsound mind.

(f) *Here state the facts.*

(g) *Here state the information, and from whom.*

PART II.

CHAPTER I.

PERSONS FOUND DEAD—REAL AND APPARENT DEATH—SUDDEN DEATH—SURVIVORSHIP.

UNDER the general heading, *Persons found Dead*, the mode of conducting inquiries concerning persons whose manner of death is unknown, will be discussed. The first question in order is the reality of death; the subject of *Real and Apparent Death* follows next; then *Sudden Death*, with the more common modes of dissolution; and, lastly, *Survivorship*.

PERSONS FOUND DEAD.

If sent for to a dying man, or to one already dead, the medical man must needs observe many things connected with the body itself, such as the position in which it is placed, and the objects that surround it, which might be observed and stated in evidence by any common witness; but a post-mortem inspection, if required, must be entrusted to some skilled member of the profession. Hence the present inquiry has two divisions. 1. *The relations of the body to surrounding objects.* 2. *Directions for the performance of post-mortem inspections for legal purposes.*

I. RELATION OF THE BODY TO SURROUNDING OBJECTS.

As the medical man is summoned to most cases of severe illness or sudden death, he is one of the first, as well as one of the best educated and most intelligent witnesses of those simple facts which, in criminal cases, constitute the presumptive or circumstantial evidence. He should therefore, especially in suspicious cases, attend to all that is passing around him, that nothing cal-

culated to throw light on the cause of death may be overlooked. The following are the principal points to be attended to :—

Place in which the body is found.—This is not always that in which death took place; for, both in suicidal and homicidal cases, persons severely wounded may be able to move from the spot on which their injuries were received, and the murderer may try to conceal his crime by carrying the body to a distance. But soldiers on the field of battle are sometimes found on the spot, and even in the very attitude in which they died.

Position and attitude of the body.—This may not correspond with the cause of death, as when the body of a man killed by a blow on the head was found erect, supported by a wooden fence; and murderers often so dispose of the bodies of their victims as to make it appear that they have committed suicide. The body of Sir Edmundbury Godfrey, who was proved to have been violently strangled, was found lying in a ditch, pierced with his own sword, and with his clothes so arranged as to create the belief that he died by his own hand; and persons have been poisoned, and afterwards suspended by the neck, or thrown into water. If we find an expression of angry resistance on the face, hands, and body of the corpse, we may infer that death was the issue of a struggle; for while soldiers killed by gunshot often wear a singularly calm expression of countenance, those who have died in a hand to hand struggle often wear an expression of rage.

Spot on which the body is found.—In cases of fatal injury to the head, it is usual to allege that the death was caused by a fall on some hard resisting body; an allegation only to be rebutted by an examination of the spot. A man found lying dead in a field with a severe bruise on the head, was alleged to have fallen on a stone or fragment of wood; but the field was carefully searched, and no such object could be found near the spot on which the body lay. In another case, a small wound of the head, which had penetrated to the brain, was attributed to a fall on a sharp object, such as a nail fixed in the floor; but the floor having been examined, and no such object found, it followed that the wound must have been inflicted by a small-pointed instrument. The murderer, who was acquitted through defective medical evidence, confessed that he had struck his victim with the point of a pair of snuffers.

Soil or surface on which the body lies.—Struggles often leave on the spot traces which may be compared with the clothes of the suspected murderer or of his victim, and foot-prints in the snow, or on the soil, have often furnished important evidence.

In the case referred to at p. 23, the measure of the foot, the tread, and the mode in which the sole of one of the shoes had been patched, corresponded most closely with the foot mark; and supplied the first link in the chain of evidence which led to the conviction of the murderer. In cases of murder, followed by the attempted suicide of the murderer, stains of blood have been found on the floor, and on the soles of the feet of the perpetrator of the double crime.*

Position of Surrounding Objects.—In suicidal cases the instrument of death is generally found near the body; in homicidal cases it is often removed and concealed. In death by the more active poisons, the vessel which contained the poison is often found on, or close to, the person. The correspondence of wounds or bruises on a dead body with the objects immediately surrounding it, sometimes throws great light on the cause of death. The Prince de Condé was found suspended by the neck in his bed-room, and the correspondence of certain abrasions on the legs with a heavy chair placed close to them, and of others on the shoulder with a projecting part of the window to which he was suspended, harmonized with the struggles of a man suspended during life, and justified the opinion of those who attributed the death to suicide.

The Clothes.—Having noted the place and spot on which the body lies, its position, and the objects by which it is surrounded, a more close inspection should be made of the body itself. The clothes may be soiled with mud, corroded by an acid, stained by blood, or some animal secretion; or they may be torn or cut. The place and character of the stains, and the direction of the rents or cuts, should be carefully noted; and cuts which traverse more garments than one should be compared with each other,

* I was indebted to the late Dr. James Reid for the following instructive case, given, as nearly as possible, in his own words:—"I was sent for one day to a man and his wife, whom I found lying in the same room with their throats cut. The woman was on the floor, with her right arm extended under the bed, and a razor close to her right hand. Her throat was deeply cut from ear to ear, and she lay in a complete pool of blood. The husband, who was in bed, had a wound in the throat, which had merely divided the trachea without wounding any important blood-vessel, and without causing any great loss of blood. When questioned, he gave the following account:—In the middle of the night he was roused from sleep by receiving a wound in the throat from the hand of his wife. The shock, the wound, and the loss of blood together, had prevented him from making any resistance or giving any alarm. My suspicions were aroused, partly by the man's manner, and partly by observing the water in a basin standing in the room slightly tinged with blood. In endeavouring to find some confirmation of my suspicions, a thought struck me. I turned up the bed-clothes and found the soles of the feet covered with dried blood. This fact, which I stated at the coroner's inquest, was deemed conclusive, but the man died almost at the moment that the verdict was passed" (G.).

and with wounds found on the body; for a murderer may tr to conceal his crime by cutting the clothes after he has wounded the body, and the wounds and cuts may not coincide. Criminals are being constantly identified through the correspondence of things found in their possession, or in places to which they have access, with those used in the perpetration of the crimes themselves. The bearing and conduct of persons in attendance on the sick, dying, or dead should not be overlooked, especially in cases of suspected poisoning.

To what has now been said respecting persons found dead, it may be well to add that neither examples nor rules can do more than suggest the sort of inquiries that may be needed. There is always great scope for individual judgment, foresight, and decision.

II. EXAMINATION OF THE BODY.—POST-MORTEM INSPECTION.

The medical man, having discharged the duty of a common witness by noting all those points of presumptive or circumstantial evidence which may throw light on the mode and cause of death, proceeds to the examination of the body itself. When it is that of some person unknown, those characteristics which may lead to its identification should be noted down, in accordance with instructions given at p. 25. Those appearances which serve to denote the time of death (see p. 248) should next be observed and then any external injuries the body may have received.

If wounds, bruises, or excoriations exist, their nature must be specified, and their extent determined by exact measurement. The neck, back, and limbs should be examined in search of dislocation or fractures, the chest compressed, to ascertain whether blood, or any fluid, mixed with air or gas, escapes from the mouth or nostrils; the cavity of the mouth inspected, in search of foreig bodies, or stains of corrosive poisons; and the anus for poisons introduced into the body by that opening. In new-born childre the orbits, fontanelles, and nuchæ should be searched for minu wounds inflicted by pointed instruments; and in women, the poi of junction of the breasts (especially on the left side) with the sk of the chest; and the organs of generation in search of poison corrosive acids, or wounds.

Post-mortem Inspection.—The great rule to be observed conducting post-mortem inspections for medico-legal purposes to examine every cavity and important organ. Even when t cause of death is quite obvious, it is well to observe this cautio for if any part of the body have been left unexamined, the obj tion may be made that the cause of death might have been fou there, or some disease which would give a mortal character to

injury not otherwise fatal. The order in which the cavities are examined must depend mainly on the supposed cause of death. As a rule, the seat of injury should be inspected first, before the contents of the blood-vessels have been disturbed by the examination of other parts. Specific directions for post-mortem examinations in cases of rape, delivery, poisoning, infanticide, &c., are given under those heads.

REAL AND APPARENT DEATH.

The risk of being buried alive, which was never very great in England, has now disappeared, and is not likely to recur unless in the improbable event of some fatal epidemic rendering speedy interment expedient. But the question of real or apparent death may assume practical importance long before the usual period of interment arrives; for in cases of suspended animation, the adoption, neglect, or speedy abandonment of measures for restoring life must depend on the previous answer to the question—Is life really extinct?

On the Continent, and especially in France, the practice of early interment, and the Roman Catholic rite of extreme unction, which raises a serious impediment to the use of means for restoring animation, has given importance to this subject. Hence such distinguished medical writers as Winslow, Bruhier, and Louis, have written treatises upon it, and it has received some attention at the iands of Mahon, Foderé, and Orfila.

There are three forms of suspended animation which may be nistaken for real death—*syncope*, *asphyxia*, and *trance*.

1. *Syncope*.—In the majority of instances, the apparent death, bout which so much has been said and written, was merely a pro-onged faint, as is proved by the success attending the accidental mployment of cold water and fresh air, the most efficacious ıeans of restoring those who have fainted.

The efficacy of cold water is attested by Hippocrates in a case f fever; and by John Howard, who bears his personal testimony) the restoration of supposed victims of gaol fever, brought out or burial, on being washed with cold water.

Diemerbröck and Zacchias attest the efficacy of pure cold air in ıses of plague; and well authenticated instances of recovery after nall-pox are on record. An infant daughter of Henry Laurens, ıe first President of the American Congress, had small-pox, and as laid out as dead; but the window of the apartment, that had ;en closed during the illness, being thrown open, the fresh air vived her. Such cases were not rare before the time of Syden-

ham, who abolished the stifling system of treating eruptive diseases, especially small-pox.

There is nothing improbable, therefore, in the cases of recovery from apparent death alleged to have occurred at the touch of the scalpel, or under the flame of the funeral pyre.

2. *Asphyxia.*—This is a form of suspended animation liable to be mistaken for real death, and only to be distinguished from it by the result of the means employed for the recovery.

3. *Trance.*—Cases of suspended animation, not answering exactly to the description of syncope or asphyxia, occasionally occur in females. The motionless and insensible state of the frame, the cold surface, and the apparent suspension of respiration and circulation, combine to produce a semblance of death, and to create temporary difficulty even for the medical man.

The subject of real and apparent death would be incomplete if some notice were not taken of those cases in which a state of apparent death has been brought about by an effort of the will. That such cases have occurred there is no doubt. A minutely de-scribed and well authenticated instance of this kind, that of the Honourable Colonel Townshend, is related by Cheyne in his 'English Malady.'

"He told us he had sent for us to give him some account of ai odd sensation he had for some time observed and felt in himself which was, that composing himself, he could die or expire when h pleased, and yet, by an effort, or somehow, he could come to lif again, which, it seems, he had sometimes tried before he had sen for us. We all three felt his pulse first; it was distinct, thoug small and thready, and his heart had its usual beating. He com posed himself on his back, and lay in a still posture some time while I held his right hand, Dr. Baynard laid his hand on his hear and Mr. Skrine held a clean looking-glass to his mouth. I foun his pulse sink gradually, till at last I could not feel any by th most exact and nice touch. Dr. Baynard could not feel the leas motion in his heart, nor Mr. Skrine discern the least soil of breat on the bright mirror he held to his mouth. Then each of us b turns examined his arm, heart, and breath, but could not by th nicest scrutiny discover the least symptom of life in him. Th continued about half an hour. As we were going away (thinkin him dead), we observed some motion about the body, and up examination found his pulse and the motion of his heart graduall returning; he began to breathe gently, and speak softly." Th experiment was made in the morning, and he died in the evenin On opening the body nothing was discovered but disease of tl

kidney, for which he had long been under medical treatment, all the other viscera being perfectly sound.

This case of Colonel Townshend is not only curious but instructive, for it shows that there is at least one state of system so nearly resembling death as even to deceive medical men, distinguishable from real death only by the continuance of animal heat, the absence of rigidity, and the success of the means of restoration. This fact also admits of practical application; for it teaches us not hastily to abandon the attempt to resuscitate those who have seemed to perish by syncope or asphyxia, by hæmorrhage, shock, sun-stroke, drowning, and the several forms of suffocation.

Signs of Death.—Of the signs of death insisted upon by authors some are trivial and inconclusive, others of considerable importance, both as signs, and as means of forming a judgment of the time that life has been extinct. To the first class belong the *Cessation of the Circulation and Respiration; the Absence of Sense and Motion; the Facies Hippocratica; the State of the Eye; the State of the Skin;* and *the Extinction of Muscular Irritability.* To the latter class belong the *Extinction of Animal Heat; Cadaveric Rigidity; Hypostasis;* and *Putrefaction.*

Cessation of the Circulation.—If no pulse can be felt at the wrist and the beat of the heart can neither be felt nor heard with the stethoscope, we may assume that the circulation of the blood has ceased, though some feeble movements of the heart may have escaped observation. The absolute cessation of the heart's action may be taken as a sure sign of death. But the difficulty is to ascertain this beyond the reach of doubt. It is not enough to feel for the pulse at the wrist, for, as in Colonel Townshend's case, even experienced medical men might be unable to detect the pulsations, and conclude that the heart had ceased to beat. The stethoscope must be applied by an experienced person for several seconds, repeated at short intervals, before it can be said with certainty that the heart has ceased to beat. But if the heart does not beat for five minutes, we may conclude that death is certain. The apparent death of the Indian fakirs is much more remarkable than that of Colonel Townshend; but there is no reason to suppose that in them the heart ceases to beat, though the vital processes may be reduced to the lowest ebb.

Seeing the difficulty attending the use of the stethoscope by uninstructed persons, Magnus has proposed an ingenious method of ascertaining whether the circulation has or has not ceased. A ligature is to be applied to a finger, when, if there is life, a bloodless ring shows itself round the seat of the ligature,

and a gradually increasing redness and lividity in the part beyond.

Cessation of the Respiration.—The circulation and respiration are so connected, that what is true of the one is likely to be true of the other. The tests of respiration—the looking-glass and feather held to the mouth, and the cup of water placed on the chest or abdomen—are at least as delicate as those by which we seek to determine the continuance of the heart's action. It is scarcely possible that respiration, however feeble, should escape detection by such means; yet in the case of Colonel Townshend, the glass remained for a long period unsoiled, and no sign of respiration could be detected. Hence it may be inferred that the suspension of the respiration is not a sure sign of death. But the joint cessation of the respiration and circulation, properly ascertained, would prove the fact of death.

These signs are confirmed by the following, which, though not of themselves conclusive, support each other.

Absence of Sense and Motion.—This is common to suspended animation and real death; and therefore uncertain. The combination is not rare in hysteric females, and in the mesmeric slumber; but in these cases the functions of circulation and respiration go on uninterruptedly, often combined with a vibrating movement of the eyelid.

The Facies Hippocratica.—This peculiar expression of countenance, combining the sunken eye, sharp nose, pointed chin, hollow temple, prominent cheek-bone, projecting ear, and wrinkled brow; the dry livid skin, and the white powdered hair of the nostrils and eyebrows; is a trivial and unsafe sign of death open to the serious objections :—1. That it is nearly always absent in cases of sudden death, and in the victims of acute disease, 2. That it is present in the dying as well as the dead, and even in cases that recover. 3. That it may be brought about by a strong impression of danger, the apprehension of a dreadful punishment, or the anticipation of certain death. And 4. That where it exists, it does not long survive the extinction of life.

State of the Eye.—A tenacious glairy mucus on the conjunctiva causing a loss of transparency, and a collapsed and wrinkled cornea, are among the best and earliest of the trivial signs of death. But they are not conclusive; for, on the one hand, the conjunctiva may be invested by a mucous film and the eye grow dim in the living, and, on the other hand, in death from *apoplexy*, *carbonic acid*, and *prussic acid*, the eyes may continue brilliant and prominent for a long time. Putrefaction, too, or a ferment introduced into the stomach, by distending the body with gas

sends blood to the head, and makes the eyes brilliant and prominent. (Nysten.) *

State of the Skin.—*Pallor,* owing to absence of circulation; *livid discolorations,* due to the subsidence of the blood; and *loss of elasticity,* have been mentioned among the signs of death. Pallor may exist during life, and be absent in several forms of death, especially in death from suffocation, and livid discolorations are common in aged and feeble persons in depending parts of the body. But loss of elasticity is a valuable sign, and one very early developed.

Extinction of Muscular Irritability.—This test was first proposed by Nysten; and is a certain sign of death. If a healthy muscle be laid bare and tested by puncture or by electricity, and there is no contraction, the body is dead; but its contraction would be a proof either of life or only recent death. Rosenthal has recently advocated it both as a sign and as a means of determining approximately the date of the death. He states that the electric excitability may continue three hours after death. If it exists, it indicates either life or recent death; and if it lasts more than three hours after life is supposed to be extinct it indicates its persistence. By this method he diagnosed a case of apparent death forty-four hours after the person was supposed to have died, and so prevented premature interment.

Among the trivial signs of death, the flexure of the thumb across the palm of the hand may be mentioned. It assumes this position before cadaveric rigidity comes on, but it is similarly contracted during life in certain spasmodic affections. The immobility of the pupil, the absence of vital reaction in the skin to irritants, &c., can only be regarded as of value when taken in conjunction with the more important indications above mentioned.

The foregoing signs do not supply the means of determining how long life has ceased. But the extinction of animal heat, rigidity, and putrefaction, being both certain signs of death, and means of determining, with more or less precision, the time at which death took place, must be examined more closely.

* Owing to the cessation of the circulation, the eyeball loses its tension, and the fundus, if examined with the ophthalmoscope, is seen to have a yellowish white hue instead of the rosy tint of life. Larcher[1] attaches some importance to a cadaveric imbibition of the sclerotic, which, at a variable period after death, begins to show a dark discoloration, first on the external aspect, and afterwards on the internal aspect of the globe, the two spots gradually growing so as to form the segment of an ellipse with the convexity downwards.

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[1] Archives Gén. de Méd., June, 1862.

SIGNS OF DEATH WHICH ARE ALSO MEANS OF DETERMINING HOW LONG LIFE HAS BEEN EXTINCT.

Extinction of Animal Heat.—The temperature of the body is closely dependent on the circulation of the blood; so that when this ceases, in a part or in the entire frame, that part, or the whole body, soon becomes cold. Hence the extremities grow cold before death; and even the internal parts, as is shown by the coldness of the breath; and at length, when life is extinct, every part becomes cold. But as, on the one hand, great coldness is often present during life, and in cases of suspended animation, and, on the other, after sudden and violent death the body often parts with its heat very slowly, the value of this sign is limited. Mere superficial coldness, as in collapse, must not be mistaken for death cooling, for there may be a high internal temperature with a very low external one. After death the body parts with its internal heat by radiation, so that the superficial temperature may rise above that which existed before death. Usually there is no further generation of heat when life is extinct, but in certain cases, as in death from cholera, yellow-fever, and some cerebro-spinal diseases, the temperature of the dead body has been observed to rise considerably above the normal temperature of life; and Mr. Savory has shown that in a rabbit and dog killed by strychnia, the temperature rose one or two degrees after life was extinct.

Nor is the extinction of animal heat a sure means of determining the time of death; for the rate of cooling varies with the age, the cause of death, the treatment of the body itself, and the state of the atmosphere; so that the period of cooling may vary from two or three hours to fifteen or twenty, and may even extend to upwards of four days.

The body cools slowly when clothed and exposed to a warm, still atmosphere, quickly when exposed naked to a draft of cold air. It parts with its heat more speedily in water than in air. Age, emaciation, and death by hæmorrhage or chronic disease, favour the cooling; youth and vigour, corpulence, and acute disease or speedy death retard it. In persons dying of the same disease, the extinction of animal heat is, *cæteris paribus*, as the rapidity with which it proves fatal. In chronic diseases, the body parts with much of its heat during life.

Some important medico-legal cases which have lately occurred (Cases of Hopley, 1860, Doidge, Gardner the Sweep, and Jesse M'Pherson, 1862), have shown the necessity of examining this subject more closely, with a view, if possible, of determining the

rate of cooling of the dead body, and the time of death. Accordingly Drs. Taylor and Wilks have recorded a series of observations on bodies transferred from the wards of Guy's Hospital to the dead-house. Out of 100 observations so made, 70 are available for a philosophical inquiry, and the facts, when submitted to careful examination and analysis, are found to yield some instructive results. The bodies, when removed from the wards to the dead-house, were placed in an open shell, and covered only with a shirt, shift, or sheet; and from the time of deposit in the dead-house the temperature of the skin of the abdomen was ascertained at various successive intervals, by the thermometer. 70 complete observations, recording the temperature of the wards and dead-house, as well as of the body, and extending from February to June, 1863, gave for the wards a range from 50° to 68° Fahr., and for the dead house from 38° to 59°. Though several of the observations extended to from 16 to 20 hours, the body, in no case, fell to the temperature of the air, the nearest approach to it being in the case of a girl æt. 19, who died of phthisis, and in whom 16 hours after death the temperature of the body had fallen to 52°, that of the dead-house being 48°. It is clear, then, that the cooling of the body, even when covered only by a single layer of cotton or linen, is a very slow process, and that in the case of a body clothed, or in bed, and in a room of moderate temperature, it would be unreasonable to expect the cooling of the body till the lapse of upwards of 24 hours at the very least. It ought also to be understood that the temperature of the body, when first ascertained two hours after death, in 18 instances presented a maximum of 88°, a minimum of 76°, and a mean of 83°; also that on an average the rate of cooling is about one degree per hour. If then, in any case, we assume the temperature of the abdomen at death to have been 90°, and the temperature of the air 60°, it would not be reasonable to expect the temperature of the abdomen to have fallen to that of the air till the lapse of at least 30 hours. These statements are the result of an analysis which we have made of the facts contained in the tables * (G.). But these facts and inferences must be applied to individual cases with great caution; for not only have we every variety of cause of death (both disease and accident), but an unusual exposure to the air and a consequent rate of cooling, which though on an average about a degree an hour, was in some cases as low as $\frac{1}{2}$°, and in others as high as 2°, 3°, or even 4°.

* On the Cooling of the Human Body after Death. By Dr. Alfred S. Taylor and Dr. Wilks: 'Guy's Hospital Reports,' Oct. 1863, p. 184.

By extracting from the tables the cases of death by accident, eight in number, assuming the rate of cooling from the period of death to the date of the first observation to have been equal to that subsequently ascertained, and disregarding the ascertained temperature of the dead-house, I have obtained the following figures as applicable to death by violence, followed by free exposure of the body to the air with a single light covering:—average temperature of abdomen at death, 83° ; range of temperature of abdomen at death, 79°—89° ; rate of cooling per hour, about 1°, or approximatively 13° in 11 hours. These are the most precise data we now possess applicable to cases of violent death ; and we cannot approximate nearer to the truth than by assuming a temperature at death of 83°, and a rate of cooling per hour of more than one degree if the body is exposed, or less than one degree if it is clothed. This is confirmed also by the observations of Letheby * who found in the bodies of adult males, with a surrounding temperature of 55°—57° Fahr., the axillary temperature 14° Fahr., and the rectal temperature 18° Fahr. *higher* than the air, so long as from 20—24 hours after death.

The use of the thermometer may be very properly insisted on in every case, as much more satisfactory than the sensations of the observer ; and it is not to be doubted that very incorrect inferences may be drawn from the sensation of cold as imparted to the warm hand of an observer on touching the hands or feet, the nose or ears, of a corpse recently dead. A man must have little experience of living bodies who does not know what a sensation of icy coolness may be imparted to a warm hand by contact with the hands or feet of another.

Cadaveric Rigidity—Rigor Mortis.—For some time after somatic death the muscles retain their irritability and contract if stimulated. The extreme duration of this irritability does not as a rule extend beyond two or three hours, and when it ceases cadaveric rigidity sets in. Before, however, rigidity becomes marked, the irritability of the muscle may be restored by the injection of defibrinated arterial blood or aerated venous blood through the vessels.

The irritability lasts longer in a low temperature than a higher one. Muscles become rigid at high temperatures—46° C. in the case of frogs, and 50° C. in the case of mammals. This heat rigidity is essentially the same as death rigidity. Rigor mortis is due to the coagulation of the muscle plasma and the formation of myosin or muscle fibrin.

* Woodman and Tidy's 'Forensic Med.,' p. 17 (note).

The muscle, formerly very elastic, becomes firm and non-elastic. If the rigidity be overcome by forcible extension of the limb, it does not return. Comparatively little shortening takes place in the rigid muscle, and cadaveric rigidity occurs in all positions of the trunk and limbs without changing those positions.

It is entirely independent of the nervous system, for it comes on in muscles whose nerves have been severed, and in paralysed limbs if the contractility of the muscles has not previously been lost. Rigor mortis occurs in the various muscles in a certain definite *order*. It shows itself first in the neck and lower jaw, then in the face, next in the chest and upper extremities, and lastly in the lower extremities.* It disappears in the same order in which it sets in, so that the lower extremities may be found rigid, while the trunk and upper limbs have become relaxed. Rigor mortis gives way to putrefactive changes.

The *time of its occurrence*, and length of *duration*, are exceedingly variable.

It may even set in before the heart has ceased to beat. On the other hand, it may be delayed for twenty-four hours or more; and it may last for a few minutes or for several days.

It occurs on the average within six hours, and lasts from sixteen to twenty-four. The experiments of Brown-Séquard† have thrown much light on the causes of variation.

From these researches it appears that whatever exhausts or depresses the muscular irritability during life, favours the early occurrence of rigidity. Exhaustion of the muscles by repeated electrical shocks, or by violent muscular exertion, causes rigidity to appear early. It sets in rapidly in animals over-driven or hunted to death, in soldiers killed late in battle, and in persons exhausted by convulsions (Savory). Though as a rule there is a period of relaxation before rigidity sets in, it would seem that under certain circumstances the muscles become rigid and fixed in the exact position assumed at the moment of death. The tetanic spasms of strychnia poisoning have been observed to pass directly into cadaveric rigidity.

This immediate setting in of rigor mortis has sometimes been termed "cadaveric spasm." It is not an unusual occurrence in cases of violent and sudden death, especially when there has been great nervous excitement. It has been specially observed in some cases of death in battle, in which the very attitude and expres-

* The order stated agrees with the various observations of Casper, Nysten, Sommer, &c., but Larcher ('Acad. de Méd.,' June, 1862) thinks the lower extremities become rigid before the upper.

† Relations between Muscular Irritability, Cadaveric Rigidity, and Putrefaction: 'Proceedings of the Royal Society,' 1861.

sion at the moment of death are retained, and weapons are found grasped in the hand. And as the soldier will be found grasping his rifle in the act of taking aim, so will the suicide or murdered person be found clutching the object he held the moment before. This fact is of great importance in a medico-legal point of view. Thus a razor or pistol found firmly grasped in the hand of a dead man is of itself a strong presumption of suicide, for it cannot be successfully imitated by a murderer. Rigidity sets in early after death by lingering diseases, accompanied by general exhaustion, such as continued fevers, consumption, cholera, scurvy, and the asthenia of old age. In the feebly developed muscles of new-born children, also, rigidity sets in early.

On the other hand, rigidity occurs *late* in cases of death in full muscular vigour. It is slow in showing itself in death from apoplexy, hæmorrhage, wounds of the heart, decapitation, injury of the medulla, and also in death by asphyxia. So also in death by rapidly fatal affections, such as acute inflammation of the viscera from irritant poisons—provided they have no specific action on muscular tissue.

As regards its *duration*, it may be stated as a general rule that if it sets in early it passes off quickly, and if it sets in late, it lasts long. To this, however, there are some very important exceptions.

In some cases in which it sets in and passes off quickly, it has been supposed that cadaveric rigidity does not occur at all. Hunter believed that in death from lightning, rigidity does not occur. This, however, is by no means true, for in many cases of death from lightning rigidity is well marked, and bodies are not unfrequently found rigid in the attitude in which they were struck. In some cases, however, it may have set in and passed off so quickly as not to attract observation. This seems to be true also of some cases of narcotic poisoning, in which, according to Casper, it is absent. In many cases in which rigidity sets in early, it has entirely disappeared in the course of one or two hours.

In those cases in which rigidity is delayed, it is often present for several days. Thus in a case of suffocation observed by Nysten, rigidity did not set in for sixteen hours, and lasted seven days. Similarly, Brown-Séquard found that rigidity in cases of death from asphyxia or decapitation did not set in on the average for ten or twelve hours, and lasted more than a week, even when the weather was warm. Taylor relates a case where the body of a man who died of apoplexy was exhumed three weeks after, in the month of January. Even at that period the limbs were so rigid that it required considerable force to bend

them. A low temperature is favourable to the persistence of rigidity; so also, according to Casper, is recent indulgence in spirits. In those cases where rigidity lasts longest, it may be found to coexist with putrefactive changes.

As exceptions to the rule that when it sets in early it passes off quickly must be mentioned the rigidity of strychnia poisoning, and many cases of cadaveric spasm. In these, though it sets in early, rigidity is often extremely pronounced and persistent.

Cadaveric rigidity can scarcely be compared with the rigidity of freezing, or with tonic vital contraction. A frozen body is uniformly stiff throughout, and crackles if gently bent, whereas in cadaveric rigidity there is always a certain degree of mobility at the joints.

The rigidity present during life in such diseases as catalepsy and tetanus, is readily distinguished from cadaveric rigidity by forcibly bending the limb: if due to a vital contraction, it resumes its position, which does not happen in the rigidity of death.

Rigidity, then, is a certain sign of death, and not to be confounded with any state of the living body; and as it supervenes after the extinction of muscular irritability, it is a sure indication of the hopelessness of attempts at resuscitation.

Cadaveric Lividity, or Hypostasis.—This, too, is an infallible sign of death, scarcely requiring to be distinguished from any condition of the living body.

In the interval between the extinction of life and the commencement of putrefraction, the body falls more and more under the influence of physical laws. The skin loses its elasticity, and the flesh its firmness, and the blood, which was equally distributed, now gravitates towards the most depending parts. Hence the paleness of some parts and the deep violet tint of others, the discoloration of the occiput and back, and of the lowest lying parts of the intestines, lungs, and brain. These discoloured patches begin to form, on an average, from 8 to 12 hours after death, and their seat is determined by the posture of the body. If it be placed on the face, they will occupy the anterior part of the body and of the viscera, and after hypostases have formed on the back, if the body be turned while still warm, and before the blood has coagulated, they will disappear. These discolorations are often very extensive, and when the body lies on a smooth surface, uniform in tint; but if the surface is uneven they are interrupted and irregular. The pressure of the clothes produces the same effect; so that a careless observer might mistake the marks of clothes fastened round the neck for the effect of strangulation, or isolated patches for severe bruises.

The extent and amount of discoloration are proportioned to the quantity of the blood, so that its prevalence through the whole body indicates a general fulness of the vascular system, and *vice versâ*. Sudden death, unattended by loss of blood, is characterized by extensive lividity; but lividity is not absent even in cases of death from hæmorrhage.

This subsidence of the blood explains the diminished intensity of colour in parts which had been the seat of the less severe and more diffuse forms of inflammation. But the appearances produced by such acute inflammation as follows burns and scalds, blisters, and strong friction, and the action of the more violent irritant poisons on the internal parts, are permanent, and quite distinct in the dead body.

Cadaveric lividity must not be mistaken for ecchymosis or extravasation into the cutaneous tissues, the result of injury. They are easily distinguished from each other by making an incision into the discoloured spot. In hypostasis the cut surfaces will exhibit a few *puncta cruenta*, or bloody points, which are the open mouths of small blood-vessels, while in ecchymosis the blood will be found diffused into the cutaneous tissues.

As hypostasis consists simply in the gravitation of the blood, whether in the skin or in the viscera, it is important when it occurs in the internal parts that it should not be mistaken for inflammation, as has happened in reference to the brain, lungs, and intestinal canal.

In connexion with this subject of the subsidence of the blood, we must notice the coagulation and consequent separation of the constituents of the blood which takes place after death. This subject, recently much investigated by physiologists, was ably treated by Sir James Paget, in a Paper published many years since,* in which he shows that the blood contained in any cavity or vessel of the body at the time of death, coagulates as it would do if drawn into a basin, or other vessel, during life; that the part of the blood which occupies the highest position in the body, like the buffy coat of inflammation in blood drawn during life, is least coloured, and that which lies lowest most; that such highest portion may be like a nearly colourless jelly, while the lowest has a deep blue or black colour; that this post-mortem separation is distinguishable from similar separations during life, inasmuch as the latter adhere in layers (as in the sac of an aneurism) to the containing cavity or vessel; and, lastly, that in most cases the blood does not coagulate in the

* On the Coagulation of the Blood after Death: 'London Medical Gazette,' vol. xxvii. p. 613.

body till the lapse of from four to six, eight, or more hours, but yet coagulates within a few minutes of being let out of the vessels. Sir James shows that these phenomena of post-mortem coagulation may have a practical application in determining the posture in which the body was left for some time after death; and he gives in illustration the case of a man suffering from excessive dyspnœa, who died sitting up with his head resting on his knees, and so remained for three or four hours after death. The relative position of the constituents of the coagula, the reverse of that usually observed, justified the opinion expressed before the facts of the case were known to Sir James, that the body had not been laid out in the usual manner.

Besides these discolorations due to the blood following the course of the vessels, there are others due to transudation. Thus the parts in contact with the gall-bladder are deeply tinged with bile.

Putrefaction.—The chronological sequence of the phenomena characteristic of putrefaction, both externally and internally, has been minutely described by Casper, and may afford some indication of the time that has elapsed since death.

External Phenomena.—The first sign is the well-known greenish discoloration of the abdomen, which may take place in from *one to three days* after death, when also the eyeball becomes soft, and yields to the pressure of the finger. After *three to five days* the green coloration has become deeper, and spread over the entire abdomen; the genitals present a dirty brown-green appearance, and large or small patches of green make their appearance on other parts, particularly on the back, lower extremities, neck, and sides of the chest. Gas is developed in the abdomen, and forces a quantity of bloody froth from the mouth and nose. In about *eight to ten days* the discoloration has become darker, and the strong odour of putrefaction is well developed. The abdomen is distended with gas. The cornea has fallen in and become concave. The sphincter ani is relaxed. In certain parts of the body the cutaneous veins are seen as red cords in the midst of patches of paler colour. *Fourteen to twenty days* after death, the body has become greenish-brown throughout; the epidermis is raised and peels off in patches; the abdomen and thorax are blown up; and the cellular tissue is inflated, so that the body has a gigantic appearance, and the features are completely obliterated. The penis is enormously swollen. The nails are loose and easily detached. The hair is also loose and easily pulled out.

The subsequent progress of putrefaction varies with the tem-

perature, and the medium in which the body lies. Thus a body far advanced in putrefaction, "at the expiration of one month, cannot with certainty be distinguished from one (*cæteris paribus*) at the end of 3–5 months." (Casper.)

The next stage is that of *Colliquative Putrefaction.*

The thorax and abdomen have burst. The sutures of the skull yield. The orbits are empty, and the liquefied tissues leave the bones exposed. These separate, the ligaments being at length destroyed.

Internal phenomena.—These first show themselves in the mucous membrane of the larynx and trachea, which, in from 3–5 days in summer, and 6–8 days in winter, assumes first a dirty cherry-red or brownish-red colour, and then an olive-green.

The rate of putrefaction in the internal organs varies greatly.

The stomach: In from *four to six* days after death dirty-red patches appear on the posterior wall, and gradually extend over the whole interior. The mucous membrane becomes soft and pulpy. These changes are sometimes mistaken for the effects of corrosive poisons.

The intestines follow next, and then the *spleen;* then the *liver,* which, however, may retain its firmness for some months after death: putrefaction commences with a green colour on the diaphragmatic surface. The *brain* follows next. It collapses after death, and putrefaction commences in the line of the vessels. In *two to three* weeks it becomes quite diffluent. The brain of children, however, is the first organ destroyed by putrefaction. The *heart* and *lungs* putrefy more slowly, so that traces of disease are distinguishable in them long after they are quite decomposed. Orfila detected pneumonia 37, and signs of pericarditis 57 days after death. The *kidneys* resist putrefaction longer even than the heart and lungs; the *bladder,* the *œsophagus,* and the *pancreas* resist still longer; and the *diaphragm* may be distinguished even after four to six months. The *uterus* resists putrefaction longest of all, and enables us to distinguish the sex after the complete destruction of all the other soft parts. Casper found it at the end of *nine months* in a fit state for examination, so that he could solve the question whether the deceased died pregnant, when all the other viscera were gone and the bones almost separated from each other.

Modifications of the Putrefactive Process.—1. Saponification —Adipocere.—Instead of passing through the various stages just described, the tissues may be converted into a soapy substance, known as *adipocere.* This peculiar transformation

was first observed by Fourcroy, at the end of the last century, during the removal of bodies from the Cemetière des Innocens at Paris. Adipocere has an appearance intermediate between fat and wax; hence its name. It is white or brownish, soft and unctuous, becoming whiter and harder when dried, and then remains for many years unchanged. It is an ammoniacal soap formed by the union of a fatty acid from decomposing fat with the ammonia given off by the decomposition of the nitrogenous tissues. Occasionally the ammoniacal base is replaced by calcium, so as to form a lime soap, especially when the body lies in a calcareous soil, or exposed to water containing lime salts in excess.

In fully formed adipocere, there is no change of structure, though fragments of unsaponified tissue may be mixed with it.

As the formation of adipocere depends on the presence of fat, it is chiefly found in the fatter parts of the body, and in largest quantity in the corpulent. The bodies of children undergo the transformation more quickly than those of adults.

Water is necessary for saponification, so that the process only takes place in bodies which have lain in water or in a damp soil. As to the length of time required no fixed rules can be laid down. It was formerly wrongly supposed that a period of thirty years was necessary for the transformation of a body; but Devergie states that one year is required if the body is in water, and about three years if buried in a damp soil. Casper thinks that adipocere is not likely to form to any considerable extent in less than three to four months in water, or half a year in moist earth, though it may be commenced at a much earlier period. In some cases it may be observed in the space of five weeks in bodies floating in water (Taylor).

It is rare for the *whole* body to become saponified; but I saw many bodies completely transformed and of a dead white among the large number of bodies disinterred while laying the foundations of King's College Hospital; and pure white specimens of the brain, and of the contents of the orbits, will be found in the museum of King's College. Saponification also takes place, more or less completely, in the bodies of fœtuses that have undergone maceration in the womb (see p. 102), and Casper relates a case where the whole of a fœtus became thus saponified *in utero* * (G.).

Mummification.—Another condition presents itself under certain peculiar circumstances. Instead of undergoing colliquative

* Casper, 'Ger. Med.,' 5th ed. vol.ii. p. 42.

putrefaction, or saponification, the body becomes dried up or *mummified*—a name which sufficiently indicates the appearance the body assumes. It is desiccated throughout; the soft parts being retained, but converted into a hard, dry, husky-looking substance, closely adhering to the bones. The odour is that of old cheese rather than that of putrefaction. The change occurs when the body is subject to conditions which rapidly abstract moisture from the tissues, as in the dry sands of the desert, or when exposed to heat and currents of dry air. It is also said to occur in arsenical poisoning, the poison acting as an antiseptic, and opposing the putrefactive changes.

Some of the bodies disinterred in laying the foundations of King's College Hospital presented only bones covered with skin, to which in parts the hair adhered. A specimen of this sort was varnished, and placed in the museum of the College.

If we would infer the time of death from the progress which the putrefactive process has made, we must pay special attention to the causes which affect it.

These are:—*External.*—Temperature, Moisture, and Access of Air; Period, Place, and Mode of Interment. *Internal.*—Age, Sex, Condition of Body, and Cause of Death.

Temperature.—Putrefaction is arrested by a temperature of 212° and of 32°: the higher temperature dries it by evaporation; the lower congeals its fluids. The most favourable temperature is one ranging from 70° to 100°. Putrefaction, therefore, takes place more rapidly in summer than in winter, and, other things being equal, varies with the temperature.

Moisture.—This is an essential condition, without which putrefaction cannot begin, or, having begun, continue. The body contains, in all its parts, moisture enough to insure decomposition; but such parts as the brain and eye, which contain most fluid are most prone to putrefaction; dropsical subjects also putrefy speedily. Putrefaction also commences soon, and runs a rapid course, in inflamed parts, in bruises, and at the edges of wounds.

Bodies which have remained some time in the water, and are then exposed to the air, putrefy more rapidly than those that have not been immersed; but in bodies which remain in the water putrefaction goes on slowly.

On the other hand, a dry air retards or arrests putrefaction. Hence the preservation of the bodies of travellers on sandy deserts. A rapid current of air has the same effect by promoting evaporation; but a moist and stagnant atmosphere encourages it, both by retarding evaporation and supplying moisture.

Access of Air.—That the presence of air promotes putrefac

tion is shown by the slow development of gas that takes place when blood or flesh is introduced into a vessel through mercury, so as to exclude all the air which does not attach to the substance introduced; also, on the other hand, by the preservation of flesh in gases not containing oxygen, such as hydrogen and nitrogen; and less completely in those in which oxygen is chemically combined with some other gas, as in carbonic acid and nitrous acid; again, in atmospheres filled with vapours that absorb oxygen, such as turpentine. Oxygen, taken separately, promotes putrefaction more than any other gas, but when combined with nitrogen, as in the atmosphere, its activity is greatly increased. The free access of air also affords the most favourable condition for the access of the minute organisms which are now generally regarded as the active agents in the putrefactive process.

Heat, moisture, and free access of air, then, are the conditions most favourable to putrefaction; and in judging of the time at which death took place, we must weigh well the amount of influence each of these agents has brought to bear on the result.

Period, Place, and Mode of Interment.—*Period.*—Bodies putrefy much more speedily in air than in the ground. Hence the longer interment is delayed, the greater the changes they undergo. Thus, during summer, a body exposed for five or six days, and then interred, undergoes at the end of a month as much change as it would do at the end of seven months, had it been interred at once (Orfila).

Site.—In dry, elevated situations, putrefaction goes on slowly; in low swampy grounds, rapidly. *Soil.*—A dry absorbent soil retards, a moist one accelerates, putrefaction. In sand or gravel the change goes on slowly, and adipocere is rarely met with: in marl or clay, and in loose mould, especially that which is impregnated with animal or vegetable matter, more quickly (except peat, which retards putrefaction). The deeper the grave, *cæteris paribus*, and the more completely the body is defended from the air by clothes or coffin, the slower the putrefaction. It is rapid when the body is in contact with the soil, but very slow when buried in a coffin hermetically sealed.*

Age.—Other things being equal, the bodies of children putrefy more speedily than those of adults and aged persons, and the bodies of old persons more rapidly than those of adults.

Sex.—According to Orfila, putrefaction is more rapid in women

* Consult Orfila's 'Traité des Exhumations Juridiques,' and Devergie's Médicine Legale,' which contains the marrow of Orfila's observations, with his own account of the changes produced by putrefaction in the water. See also Casper's Handbook, vol. i. p. 30.

than in men. He attributes this to the greater quantity of fat they contain, an explanation which, though not quite satisfactory, agrees with the fact that the corpulent putrefy more readily than the lean and emaciated. Casper, who disputes the influence of sex, observes that the bodies of women dying during, or soon after child-birth, putrefy very rapidly.

Condition of Body and Cause of Death.—Putrefaction takes place most speedily in bodies filled with fluid. Hence it is very rapid after sudden death, and death from acute disease (*e.g.* 15 hours in a woman dying from hydrophobia in mid-winter—Sauvage); slower after death from hæmorrhage, or chronic diseases, unless complicated with dropsy, or extensive structural change, as in typhus, and typhoid fevers, small-pox, erysipelas, septicæmia, &c.

What is true of the whole body is true also of its parts; for those which are full of fluid at the time of death, through inflammation, congestion, or dropsy, wounds or bruises, putrefy more rapidly than healthy and entire structures. In some instances, as in low fevers, the extremities are attacked before the trunk has ceased to live.

It was formerly believed that the bodies of persons killed by poison putrefied very rapidly; but this is now known to be a mistake. Casper specifies phosphorus, alcohol, and sulphuric acid, to which we may safely add arsenic and other mineral poisons, as retarding putrefaction, and though he classes smoke and carbonic acid with sulphuretted hydrogen and narcotic poisons, as hastening it, it appears from three cases reported by Devergie that in death by carbonic acid the process is decidedly retarded. Animal and vegetable poisons have probably no effect either way; persons killed by them putrefy rapidly, as in other cases of speedy death. Putrefaction takes place with unusual rapidity in animals driven soon after a meal and dying suddenly;* in men dying suddenly during violent exertion; and in soldiers killed late in battle.

Putrefaction in Water.—More dependence is to be placed on the criteria laid down for determining the period of death of bodies which have remained in the water, than of those exposed to the air or interred, for the temperature of the water is more uniform, and the body, unless when it rises to the surface, is protected from the air. As Devergie, whose official position at the Paris Morgue gave him unusual means of observation, place

* See two striking illustrations of this, one in a pig, the other in a man in my edition of Walker's Original, p. 24 (G.

much reliance on the signs by which the period of death is determined in the drowned, the following account based upon his description is subjoined:—

The bodies of the drowned are subject, like those who perish in other ways, to loss of heat and rigidity, and to putrefaction, but in a modified form, accompanied by the formation of adipocere. One of the first changes, which occurs as early as the *third or fourth day*, consists in bleaching of the skin of the hands. *At the end of a week* the body is found supple, and the skin of the palms of the hands very white. *A week to twelve days* of immersion bleaches the backs of the hands, and softens and bleaches the face. *At the end of a fortnight* the hands and feet are bleached and wrinkled, the face slightly swollen with spots of red, and the middle of the sternum has a greenish tint. *At the end of a month* the hands and feet are completely bleached and wrinkled as if by a poultice, the eyelids and lips are green, the rest of the face reddish-brown, and the front of the chest presents a large green patch with a reddish-brown spot in the centre. *At the end of two months* the face is swollen and brown, and the hairs are but slightly adherent: much of the skin of the hands and feet is detached, but not the nails. *At two months and a half* the skin and nails of the hands are detached, and the skin of the feet, but the toe-nails still adhere. In the female, reddish discoloration of the subcutaneous cellular tissue of the neck, of that surrounding the trachea, and of the organs contained in the chest; partial saponification of the cheeks and chin; superficial saponification of the mammæ, the axillæ, and the fore part of the thighs. *At three months and a half*, the skin and nails of the hands and feet are completely removed; part of the hairy scalp, of the eyelids, and of the nose, and the skin of many parts of the body destroyed; and the face and upper part of the neck and axillæ partially saponified. *At four months and a half*, nearly total saponification of the fat of the face, of the neck, of the axillæ, and of the anterior part of the thighs, with commencing earthy incrustation; incipient saponification of the anterior part of the brain; opaline state of the greater part of the skin; almost entire separation and destruction of the hairy scalp; calvarium denuded and beginning to be very friable. As to more remote periods no accurate approximations can be given.

Devergie alleges that the above signs have been repeatedly applied with complete success to bodies that had been in the water for unknown periods.

The foregoing description applies to bodies immersed during winter. Bodies immersed in summer undergo the same changes

much more rapidly. Thus, 5 to 8 hours in summer correspond to 3 to 5 days in winter; 24 hours to 4 to 8 days; 48 hours to 8 to 12 days; 4 days to 15 days. On the average, then, the same changes in summer take place from three to five or six times as rapidly as in winter, or even more promptly than that, the changes in spring and autumn being intermediate.

That development of gas within the body which causes it to rise to the surface, takes place slowly in winter, and the body rarely floats in less than six weeks or two months. The same change takes place in summer from the 14th to the 16th day, or even earlier.

Of putrefaction generally, as a means of fixing the period of death, it should be observed that it is surrounded with difficulties, in consequence of the many elements that must combine to produce these changes in the body. So that we read without surprise the following statements:—"On the 20th March, 1848, I examined the bodies of fourteen men, almost all of the *same age*, 24—30 years, previously occupying precisely the *same social position* (workmen of the lowest class), all lying together in the *same* part of our dead-house, who had all met the *same* death, having been shot on the barricades on the 18th of March, and had all notoriously died at the *same* time." "And yet I can testify that in no one case did the signs of putrefaction resemble those of another." "An old couple of about the same age 50—60 years were suffocated during the night by carbonic acid gas. Up to the time of our examination, these bodies had been exposed to precisely similar influences, and yet on the fourth day after death (in November), the body of the man was quite green, both on the abdomen and the back, and the trachea was brownish-red, from putridity, &c., while his uncommonly fat wife was perfectly fresh both outside and in." (Casper's Handbook, vol. i. pp. 33 and 34). In the face of facts like these, we find both French and German authors speaking with much confidence of the value of the signs of putrefaction; and even Casper himself stating that at a similar average temperature putrefaction in the open air, in water, and in a coffin, will have advanced equally after the lapse of one, two, and eight months respectively.

THE MODES OF DEATH.

The proximate causes of death, whether from natural decay, disease, or violence, may be reduced to two—viz., cessation of the circulation, and cessation of the respiration. On the continuance of these functions, and particularly of the former (if these may be specified where all are essential), the life of the body as a whole,

and of the individual organs and tissues depends. These functions may cease from causes operating directly on their mechanism, but also by causes operating indirectly through the nerve centres by which they are regulated. Hence it is usual, in accordance with Bichat's classification, to speak of three modes of death—viz., death beginning at the *heart*, death beginning at the *lungs*, and death beginning at the *head*. This classification is convenient, for though death beginning at the head is in reality death by failure of the circulation or respiration, or both, through affection of the vital nerve centres, yet the affection of the nervous system is the primary fact, and the phenomena are sufficiently characteristic to deserve separate consideration. It must, however, always be borne in mind that owing to the interdependence of all the vital functions there is no such sharp line of demarcation between the different modes of death as we make between them for purposes of classification.

1. *Death from Failure of the Circulation.*—This may be sudden, as in *syncope* and *shock*, or it may be gradual, as in *asthenia*.

Sudden Failure of the Circulation. For an efficient circulation it is necessary that there should be a sufficient quantity of blood or vascular tension, and a differential tension in the arteries as compared with the veins. The circulation will be brought to a standstill by any cause which greatly lowers the vascular tension or annihilates the differential pressure in the arterial system. The cause may be in the heart, or in the vessels, or both.

In the *heart.*—As the pumping action of the heart is the chief factor in the maintenance of the arterial tension, all organic or structural diseases which render it incapable of propelling its contents into the arterial system will naturally result in the cessation of the circulation and death. Under this head are classed all diseases of the heart and its annexes.

But apart from structural disease or degeneration, the heart may suddenly cease by nervous shock conveyed through the vagus nerves. The heart may be inhibited temporarily, or finally, and for ever, by central nervous influence, as by emotion, or blows on the head; or reflexly, as by a violent blow on the epigastrium, or by sudden irritation of the sensory nerves of the stomach, as in corrosive poisoning; or even by swallowing a large quantity of cold water when the system is overheated.

Death from sudden cessation of the heart's action is death from syncope. Syncope, however, may be merely transitory, as in ordinary fainting.

In syncope there is sudden loss of consciousness, owing to diminished pressure in the cerebral centres. A deadly pallor over-

spreads the skin, with superficial coldness, and life may become extinct without any further symptom.

In the *vessels.*—Rapid fall of the blood pressure and cessation of the circulation will naturally result from great loss of blood owing to rupture of the vessels from injury, or disease such as aneurism. This is death from hæmorrhage. But without actual loss of blood the vascular area may, under certain conditions, become so dilated, and the differential pressure so lessened, that the circulation ceases. This is what occurs in death from *shock* or *collapse.* From blows on the abdomen, or violent irritation of sensory nerves, the vascular area of the viscera becomes so dilated as practically to retain almost the entire volume of blood in the body. Hence, even though the heart may continue to act, yet little or no blood flows through it. The animal, as it were, dies of hæmorrhage into its own veins. This has been experimentally shown to occur in frogs from blows on the intestines. It is seen in cases of traumatic shock, more especially from abdominal injuries. The individual suffering from shock merely, still retains consciousness, and thus differs from one affected by syncope. Frequently, however, more especially from blows on the abdomen, there is not merely reflex dilatation of the abdominal vessels, but also temporary inhibition of the heart, so that syncope and shock coexist, and the individual is unconscious. But syncope may pass off, leaving the symptoms of shock remaining. Shock, like syncope, may be transient or fatal. In this condition there is pallor of the face and lips, superficial coldness, cold sweats, muscular relaxation and dilated pupil. The patient complains of giddiness, tendency to syncope if raised from the recumbent position, dimness of vision, ringing in the ears. The pulse is almost imperceptible, the respiration sighing and gasping. There is frequently nausea and vomiting, restlessness and tossing of the limbs, transient delirium and convulsions.

In death from failure of the circulation, the post-mortem appearances vary according to whether the cause has been in the heart or vessels. Structural disease, or fatty degeneration of the heart, will reveal itself on examination. The cavities of the heart may be found full, the heart having been unable to contract on its contents. Inhibition of the heart without structural disease will not reveal itself by any special morbid appearances in the heart itself, though it is most likely to occur in a heart already weakened by degenerative processes. In reflex inhibition the heart stops in the state of diastole, but this may not be observable on post-mostem examination, as the heart may empty itself on the setting in of cadaveric rigidity.

In death from shock, the heart is quite empty, and the blood accumulates in the abdominal veins. Death from hæmorrhage reveals itself in an unnatural pallor of all the internal organs, and an almost empty state of all the venous trunks. If the hæmorrhage has been internal, the blood will be found internally, and the ruptured vessels will in most cases be discoverable.

2. *Gradual Failure of the Circulation.*—This may be termed death by *asthenia* proper, though the term is sometimes employed differently. It is the natural termination of life from decay, and is comparatively rare, death in the aged being frequently due to some intercurrent affection. It is also the mode of death after wasting and exhausting diseases, cold and starvation. The vital powers fail gradually, and life often passes away so quietly that it is difficult to say when the last spark has been extinguished.

3. *Death from Failure of the Respiration.*—This is termed death from *asphyxia*, which literally means *pulselessness*, but is generally understood to mean the condition that supervenes on interruption of the function of respiration. Attempts have been made to substitute for this the term apnœa, as being more exact, but this tends only to create confusion, as apnœa is employed by physiologists to signify a condition of cessation of the respiratory movements when the blood is artificially kept oxygenated. The older term asphyxia, though etymologically inexact, is yet sufficiently well understood.

Asphyxia may result from many causes of obstruction to respiration. They may be divided into two categories—internal and external.

Internal.—Under this head we may include paralysis of the respiratory nerve-centres from disease or injury of the medulla oblongata; injury or paralysis of the nerves or muscles of respiration—as by curara, conia, &c.; rigid fixation of the muscles of respiration, as in the tetanic convulsions of strychnia poisoning; collapse or disease of the lungs, rendering the lungs incapable of expanding or aërating the blood; occlusion of the pulmonary artery; air in the veins; occlusion of the air passages by organic disease or spasm of the glottis, pressure of tumours, and the like.

External.—To this group belong occlusion of the air passages by foreign bodies; pressure on the chest not capable of being overcome by the muscles of respiration, as in dense crowds, and even (as in a remarkable case on record) in taking a plaster cast of the chest; closure of or pressure on the air passages, as in suffocation, strangulation, hanging. These are all cases of obstruction of the respiration in a medium supposed capable of sup-

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porting life. To these are to be added conditions in which, though the respiratory movements are free, the surrounding medium is incapable of oxygenating the blood—viz., submersion in a liquid medium (drowning); or an atmosphere devoid of oxygen, such as hydrogen or nitrogen. These gases have a purely negative effect, but many other gases which are classed as asphyxiants, such as carbonic oxide, sulphuretted hydrogen, chlorine, &c., have positive toxic effects, besides being unable to support respiration. We may term such vapours *toxic asphyxiants*.

Phenomena.—When a warm-blooded animal is placed in an atmosphere devoid of oxygen, or not containing a sufficient proportion of this gas (under 10 per cent.), or if the mechanism of respiration is in any way obstructed, it begins to exhibit signs of agitation, and to make powerful expiratory and inspiratory efforts, during which all the accessory muscles of respiration are brought into action. The vascular tension increases, and the superficial veins become distended, the surface livid, and the eyeballs protrude. The individual at this stage experiences a sense of fulness of the head, ringing in the ears, and various sensory illusions, sometimes of a pleasant character.

Soon total unconsciousness comes on, and the dyspnœic efforts pass into general convulsions, in which the muscles of expiration are more particularly in action, and in which the sphincters are forced and the excretions voided. On these convulsive efforts there follows a calm, in which the animal lies insensible, with dilated and immovable pupils, and reflex excitability abolished generally. All muscular movements cease, except those of inspiration, which are repeated at intervals. As death approaches these become shallower and irregular, and are succeeded by stretching convulsions, during which the back is straightened, the head thrown back, the mouth gapes and the nostrils dilate. The heart continues to beat after all other movements have ceased; and ultimately stops in diastole. Death is then final.

Course and Termination.—The time necessary to bring about a fatal termination varies. It has been observed that the young of some animals resist asphyxia longer than the adults. The differences according to Bert depend on the relative activity of the internal respiratory processes. The greater the gaseous interchange the more rapidly fatal is obstruction of the respiratory functions. Excluding special considerations, it may be stated as the result of the Med.-Chir. Committee's experiments,* that when the respiration of a warm-blooded animal is totally obstructed, all external movements cease in from 3 to 5 minutes,

* 'Med.-Chir. Trans.' vol. xlv. 1862.

and the heart stops within 10 minutes. Certain modifications occur according to the method in which asphyxia is produced. (See Drowning).

5. *Post-mortem Appearances.*—After death by asphyxia livid patches are seen on various parts of the body, and cutaneous hypostasis generally is well marked. The blood is dark and completely reduced. It remains long fluid, and coagulates very imperfectly. The venous side of the heart, the great venous trunks and pulmonary arteries, are gorged with dark blood, while the left side of the heart is completely empty, or contains only a comparatively small amount of dark blood. The lungs are sometimes congested, but this is by no means constant. Often, and especially if the respiration has been completely obstructed from the first, the lungs are pale at first, but become hypostatically congested posteriorly after some time. The lining membrane of the air passages is frequently injected, and coated with a sanguinolent froth. Punctiform ecchymosis may be seen on the surface of the lung, and some of the air cells are distended or ruptured. The abdominal viscera are usually congested. The state of the brain varies. Sometimes it is found congested, with numerous *puncta cruenta*, and serous effusion, but there may be no abnormal appearance.

Various other signs characterize the special modes in which asphyxia has been brought about.

6. *Pathology.*—Inasmuch as asphyxia implies both a deficiency of oxygen and an accumulation of carbonic acid, the question has been debated as to which is the essential factor. The experiments of Pflüger, Rosenthal, &c., seem to demonstrate that the phenomena are mainly due to the oxygen starvation. But that the accumulation of carbonic acid has no effect at all cannot be maintained, for it is demonstrable that carbonic acid has a direct effect on nerve centres and living tissues generally.

The circulation of non-oxygenated blood through the lungs and respiratory centres in the medulla is the cause of the active respiratory efforts in the first stage, both by direct irritation and reflex stimulation. The respiratory movements increase in force, and the irritation of the respiratory centres radiates into the centres for other movements, giving rise to the expiratory convulsions, ascribed by some to irritation of a so-called "convulsion-centre." These centres become ultimately paralysed, but the medullary centres retain their vitality after the brain and spinal cord have lost their excitability. The circulation of non-oxygenated blood likewise causes constriction of the arterioles. Increased resistance is thus offered to the heart, and this is intensified by the convulsive movements. This resistance occurs both in the

systemic and pulmonary capillaries. The ventricles in consequence become distended, and the heart's action laboured. The heart becomes enfeebled by the circulation of non-oxygenated blood in its walls, the diastolic intervals become longer, and it finally stops in the state of diastole with both cavities full of dark blood. On the setting in of cadaveric rigidity, however, the left ventricle usually succeeds in emptying itself, so that as a rule the right side is seen full, and the left empty and contracted.

7. *Death from Paralysis of the Vital Nerve Centres.*—Under this head we include those forms of death in which the functions of the brain are primarily interfered with, giving rise to *coma*, and leading to death, secondarily, by paralysis of the centres of respiration and circulation.

The causes of coma are numerous. It may be brought about by pressure on the brain, by fractures of the skull, effusions, hæmorrhagic or otherwise, or tumours within. Or it may be due to the circulation in the blood of poisons—classed generally as the *narcotic* poisons—introduced from without; or of poisons generated in the system, as in uræmia, and in other cases of non-elimination of waste products. Coma may come on gradually or suddenly, according to the cause. Affections of the brain causing coma—such as cerebral hæmorrhage, are rarely suddenly fatal. Sudden death occurs only when the effusion is at the base. In coma the individual lies in a state of unconsciousness, from which he cannot be roused. There is complete insensibility to external impressions, the breathing becomes stertorous and finally ceases, death occurring quietly or in convulsions.

The *post-mortem* appearances in death from *coma* are essentially those of asphyxia, which is the proximate cause of death; but apart from structural changes (the cause of the coma), congestion of the brain and its membranes, is more marked and constant than in death in asphyxia from other causes.

VIOLENT AND SUDDEN DEATH.

Upwards of 3000 sudden deaths occur year by year in Englan[d] and Wales from causes not ascertained, over and above the 15,00[0] returned as due to violent causes, of which the greater numbe[r] also belong to this class.

The following facts relating to sudden death are taken fro[m] the 19th Annual Report of the Registrar-General. Of 416,47[?] deaths from all causes, occurring in England and Wales, on th[e] average of the five years 1852–56, 13,711, or about 1 in 3[0] were violent deaths, of which 3045 were due to various forms [of]

chemical injury, 3826 to asphyxia, and the remaining 6840 to various mechanical injuries. Of the 13,711 violent deaths, 10,057 occurred in males, and 3654 in females. The sudden deaths, for the average of the same five years, are stated at 3843, or nearly 1 per cent. (1 in 109). They are distributed between males and females in the proportion of about 3 to 2.

The suicides on the average of the same five years amounted to 1083, of which 777 were men and 306 women. Of 1044 due to ascertained causes, 642 were by various forms of suffocation, 111 by poison, 1 by burning, and the remainder by mechanical injuries; among which 210 cut throats, 43 gun-shot wounds, 12 other wounds, and 20 falls. The suicides by poison of men and women respectively were as 6 to 5, by asphyxia as about 3 to 1, and by mechanical injuries as about 4 to 1. The greatest number of suicides in both sexes occurred between the ages of 45 and 55.

According to Ogston * the most common causes of sudden death, excluding violence and poison, are as follows:—1. Diseases of the heart, especially fatty degeneration, angina pectoris, aortic regurgitation, interstitial abscess, rupture of the heart or of its valves, and diseases of the pericardium. 2. Diseases of the blood-vessels, especially aneurism and thrombosis; the aneurisms most likely to end thus suddenly are intra-cranial, intra-pericardial, abdominal and pulmonary. 3. Large effusions of blood in the brain or its membranes. 4. Pulmonary apoplexy and hæmatothorax. 5. The sudden bursting of visceral abscesses. 6. Ulcers of the stomach, duodenum, or other parts of the alimentary canal. 7. Extra-uterine fœtation, peri- and retro-uterine hæmatocele, apoplexy of the ovary, rupture of the uterus. 8. Rupture of the urinary or gall-bladder, or of some other viscus from accidental violence. 9. Cholera and some zymotic diseases kill very rapidly. 10. Large draughts of cold water when heated. 11. Mental emotions (fear, grief, joy). 12. Foreign bodies accidentally swallowed, and obstructing the glottis.

Ferrario and Sormoni found the sudden deaths in Milan to be distributed as follows:—Head (apoplexy, cerebral concussion vertigo, and coma), 879, or about 4 in 5. Heart (angina pectoris, aneurism, and hæmorrhage), 150, or about 1 in 7. Lungs (asphyxia, suffocative catarrh, and pulmonary apoplexy), 14, or about 1 in 75. Difficult labours, 5; total 1048.

The relative frequency of the different forms of sudden death classified according to their proximate causes must, however, be

* Quoted by Woodman and Tidy, 'For. Med.,' p. 636.

understood to differ at different periods of life. The above proportions are obviously those that obtain chiefly among adults; for sudden deaths in infancy and childhood, if classed according to their causes, would reverse the order just stated. By far the most frequent cause of death in infancy and childhood is to be found in the lungs, and the least common in the brain. The diseases of the lungs which give rise to sudden or speedy death in infants and young children are spasmodic croup or laryngismus stridulus, to which Dr. West attributes three out of four of the sudden deaths of children under one year, imperfect expansion of the lungs at birth (atelectasis pulmonum), sudden collapse of the lung, consolidation from pneumonia, and sudden serous effusion into the pleura, to which ought to be added a disease not mentioned in the paper now referred to, pulmonary apoplexy. A not uncommon cause of sudden death among the children of the poor is suffocation, as a consequence of drinking hot water from the spout of the kettle. Next to diseases of the lungs, sudden death by exhaustion from insufficient food, or chronic diarrhœa, is most common, while fatal disorders of the brain are very rare among the causes of sudden death in infancy and childhood.* Of the sudden deaths entered in the tables of the Registrar-General upwards of one-third occur in infancy.

SURVIVORSHIP.

When two or more persons die by the same accident, a question may arise as to which died first; for, in certain cases, the succession to property would be secured on proof of survivorship even for an instant.

Little has yet been done towards establishing general principles applicable to this class of inquiries, chiefly from want of the requisite materials. Some of the more accurate results which have been attained will be found stated under the following heads:—1. *Of the probabilities afforded by age and sex, irrespective of the mode of death.* 2. *Of the degree in which such probabilities are affected by the mode of death.*

I. OF THE PROBABILITIES AFFORDED BY AGE AND SEX.

Age.—As the body attains its full growth and strength at about 27 years of age, or from 25 to 30, and healthy persons

* See a Lecture by Dr. West, on Sudden Death in Infancy and Childhood, in the 'Medical Times and Gazette,' Nov. 26, 1659.

continue strong and vigorous up to about 50, there will be no sufficient ground for inferring survivorship in the case of adults of the same sex, whose ages range between 25 and 45, or even between 20 and 50, provided the form of death be one in which mere strength and power of endurance is concerned. Before and after the ages specified, these will be less; but still within the limits of puberty and old age (say 15 and 60 years) the difference will probably be inconsiderable. The probability of survivorship, in the case of a middle-aged adult perishing with one under puberty or above 60, will be in favour of the adult. In the case of one under 15 and one above 60 perishing together, the French law assumes that the former survived: when both are under 15, that the elder outlived the younger. According to the civil law of England, if parent and child perish by a common death, the child is presumed to have survived if above, and to have died first if under, puberty.

In the case of a mother and child both dying in childbed, without assistance, the presumption is, that the mother survived; for there is a chance of still birth, and a further probability that the child, if born alive, would die before the mother could render it the assistance necessary. A large child would be still more likely to perish first, for, as elsewhere stated, still-born children greatly exceed in size and weight those born alive. If the child's body could be examined, the presumption might be strengthened by the marks of a difficult labour, or the absence of the signs of respiration. Legal decisions have not always been in conformity with the principle here laid down.

Sex.—If a male and female perish by a common accident, in which strength and courage give the best chance of safety, it may be inferred that the male, being the stronger, is the survivor. But females, being subject to prolonged faintings from fright, may be, by that very circumstance, incapacitated from those struggles which in so many forms of death may be presumed to increase danger. When, then, there is safety in exertion, the probability of survivorship will be with the male; when in passive endurance or insensibility, with the female.

I. OF THE DEGREE IN WHICH THE FOREGOING PROBABILITIES ARE AFFECTED BY THE MODE OF DEATH.

Under this head some common modes of death will be speci-ied, and an attempt will be made to establish some general prin-iples with respect to them, assuming, as before, that the parties bout whom the question is raised are placed, as nearly as may e, in the same circumstances.

Asphyxia.—Women consume less oxygen than men; hence the same quantity of air will last them for a longer time; and of adult males and females perishing together by asphyxia; the females may be presumed to have survived. In poisoning by the oxides of carbon, the chances of survivorship are with the female. This statement rests on the authority of a large number of facts. In 19 out of 360 cases of poisoning by charcoal fumes which took place in Paris during 1834 and 1835, a man and woman were exposed to these gases together: of these three only were saved, and these three were females. In solitary cases of the same form of death the result is also favourable to the female; for 18 out of 73 females were restored, and only 19 out of 83 males, so that the chances for the female and male respectively are nearly as 15 and 14 (instead of 5 and 4 as Devergie represents it). Single cases are in conformity with this result. Thus, in a case quoted by Beck from the 'Transylvania Journal,' a man and his wife were exposed in a small room to the gas from live coals. The man was found dead and rigid, but the woman was still breathing, and recovered. Again, in a case reported by M. Sardaillon, a man, his wife, and their child, aged seven years, were asphyxiated in a porter's lodge. The child died, the father was very ill, and with difficulty restored to life, while the wife was able to call for help and to assist both husband and child. In these cases we must take into account the position the parties occupied in the room, whether on the bed or floor, near to or remote from an open window, &c.

Drowning.—There are many complicated considerations connected with this mode of death. In shipwrecks men are more likely to be in a favourable situation for saving themselves, as they are more on deck, less encumbered by clothing, more likely to be able to swim, or to cling to floating portions of the wreck. When the comparison is between men similarly exposed and capable of the same exertion, we may have to inquire whether one was more exposed to cold by having the body half immersed, while the other was more under water. Search should also be made for severe injuries which may have prevented the swimmer from using his strength, or may have otherwise proved fatal. Apoplexy is stated by Devergie to be sooner fatal than asphyxia, while in syncope there is the best chance of recovery.

Suffocation.—In all cases of suffocation depending upon an insufficient quantity of air, or upon air rendered partially unfit for respiration, it may be be presumed that those who require least air live the longest—women longer than men, children than adults. In suffocation from the falling of houses or earth, or by

mechanical means in general, the stronger may be presumed to survive the weaker—men, women; adults, children and old persons.

Cold.—As young children bear cold worse than adults, the probability of survivorship in exposure to the same degree of cold is in favour of the latter. Men bear cold better than women, adults better than the aged. It is necessary also to take into account the clothing of the exposed persons and their state of health. Spirituous liquors in excess increase the effect of cold.

Heat.—The young and old, as they suffer more from cold, so do they bear heat better. The relative tolerance of heat of the two sexes is not well ascertained. Foderé relates the case of an Englishman and his daughter, aged seven years, who, in the year 1814, crossed the desert of Syria to the Persian Gulf. Both rode on camels, and were placed in precisely similar circumstances, but the father died, while the child arrived safe at its journey's end. This result might, however, be explained by the greater exertion which the parent would have to make.

Hunger and Thirst.—Those who have not reached their full growth require more nourishment than adults, and adults more than aged persons. The aged, then, if healthy and robust, may be presumed to survive both, and the adult to live longer than the child. Corpulent persons are thought to bear hunger better than the spare. In death from starvation, free access to water greatly lengthens life. Those who use most exertion suffer earliest in this as in the foregoing modes of death; while those who possess most passive endurance may be expected to live the longest.

Such are some of the forms of death in which the circumstances of the several victims are likely to be so similar as to admit of the application of general rules. In other modes of death, and in these under certain circumstances, there may be no points admitting of strict comparison, and many things which may exercise a marked influence on the result will have to be taken into account. The reader will find several such cases quoted in Beck's 'Medical Jurisprudence;' but as they throw little light upon the general question, and establish no fixed principles, they are not quoted here.

It has been suggested that a distinct enactment would be preferable to the custom of deciding each case on its own merits. Such an enactment, extending to that large class of cases in which the circumstances of the death are imperfectly known, and in which in the nature of things it is impossible to come to a correct decision, is certainly much to be desired.

CHAPTER II.

DROWNING—HANGING—STRANGULATION—SUFFOCATION.

THESE modes of death are brought together in the same chapter, as they all involve asphyxia,* or death beginning at the lungs.

DEATH BY DROWNING.

The medico-legal importance of this subject may be inferred from the fact, that in 1871 (the year of the census), 2922 deaths were caused by drowning, of which 2348 in males and 574 in females. Of this number 317 (173 males and 144 females) were ascertained acts of suicide.

Death by drowning is commonly attributed to asphyxia; but it is not always due to that cause; it will be necessary, therefore, to describe the various modes in which a man who has died in the water may have come by his death.

When a man in perfect possession of his faculties falls into the water, he sinks to a greater or less depth, but immediately rises to the surface again; and, if he is a swimmer, makes efforts to save himself, till at length he is reduced to the condition of one who cannot swim at all; with this difference, that he has already exhausted the strength which the other has in reserve for the death struggles common to both. These struggles consist of irregular movements of the arms and legs, and grasping of the hands at all objects within reach, whether floating in the water, fixed at the bottom, or growing on the banks. In the course of these irregular movements he rises repeatedly to the surface, tries to breathe, and takes in air and water. The contact of the water with the windpipe causes a cough, by which part of the fluid is rejected, and with it some air from the lungs. This

* The term 'apnœa,' employed in the last edition of this work, though recommended by high authority, is throughout this edition replaced by the word 'asphyxia.'

occurs again and again, till the body no longer rises to the surface; water alone is received in the vain efforts to inspire, while forcible involuntary expirations continue to expel air from the chest. At length all these efforts cease, the body sinks to the bottom, and bubbles of air are forced out by the elastic reaction of the walls of the chest. Most of the water entering the mouth finds its way into the stomach, the rest into the lungs; and this residue, mixed with the secretions of the mouth and air-passages, and frothed by the air inspired and expired, forms the foam so constantly met with in persons who have perished in this way.

In these cases we find the characteristic marks of asphyxia, coupled with those due to the medium in which the death takes place. In the case of the swimmer, death may take place from exhaustion, with less distinct marks of asphyxia.

But death may take place in the water, and yet be caused neither by asphyxia nor by exhaustion. There may be complete loss of consciousness at the moment of immersion. This may happen from fright, drunkenness, an attack of hysteria, or of catalepsy (of which we have known one instance) (G.); and in this case the body falls to the bottom, rises again to a certain height, and sinks without a struggle, death being due to shock or to syncope.

A man may fall, or throw himself into, the water head foremost, and, striking against some solid substance, or even against the water itself, perish by concussion; or falling, or being thrown, from a height, may strike the water with the chest and pit of the stomach, and die instantly from shock.

Again, cold, excitement, or the first violent struggles, may occasion apoplexy, or sudden death from disease of the heart. Such deaths occasionally occur in persons bathing in cold, shallow water.

Death by drowning may also be of a mixed character. A man alls into the water in full possession of all his faculties, which ie preserves for a time, till, struck with horror at the death vhich threatens him, he faints, and thus perishes.

It appears, then, that death by drowning may be due to ashyxia, to exhaustion, to shock, to syncope, and to apoplexy; or artly to asphyxia, partly to one or other of the causes just speciied, and these mixed cases are much the most common; while those n which asphyxia and its signs are wholly absent form a small ninority, and cases of pure and unmixed asphyxia occupy an ntermediate place. Devergie, whose large experience of the rowned has been already alluded to, estimates the cases of unnixed asphyxia as *two in eight* of the whole, the cases in which

no traces of asphyxia exist as *one in eight*, and the mixed cases as *five-eighths*.

The appearances in the body of the drowned must necessarily vary with the manner and cause of death.

Where death has been due to asphyxia, the post-mortem appearances will be those proper to that mode of death (see p. 265), blended with those due to the medium in which the death happened, and modified by the time the body has remained in the water, as well as by the length of the subsequent exposure to the air.

If in death by asphyxia the examination be made soon after the death and removal from the water, the following appearances may be present:—The face and general surface of the body are pale or slightly livid, with patches of a deeper tint. The expression of the face is generally calm. The tongue is swollen, and closely applied to the teeth, rarely protruded between the closed jaws, and still more rarely wounded and bloody; and there is a frothy foam at the mouth. The air-passages also contain a froth, sometimes tinged with blood; and the trachea and larger bronchial tubes contain water, which penetrates to their most minute ramifications, and may fill the whole of the air-passages. The water occasionally carries with it slime or mud, or fragments of aquatic plants. The lining membrane of the air-passages is sometimes congested; the lungs are distended and œdematous, and exude a sanguinolent frothy liquid when incised. The venæ cavæ and right side of the heart are filled with dark blood, while the left cavities are comparatively empty. The stomach almost always contains water, sometimes in considerable quantity. The intestines have a rosy colour; the liver, spleen, and kidneys are gorged with blood; and the bladder sometimes contains bloody urine. The brain presents the same appearances as in other cases of death by asphyxia. Sand or mud is often found in the hollow of the nails, the fingers are sometimes abraded, and portions of plants growing in the water, or on the banks of the stream, may be found grasped in the hands. Injuries received in falling into the water during the death-struggles, or through the violence of the stream, may also leave their marks upon the body.

In bodies that have remained in the water, or been exposed to the air for some time, the pallid, or slightly livid hue of the features may be exchanged for a bloated appearance, and large livid spots may show themselves on different parts of the body, as in other cases of death by asphyxia.

In death by shock, syncope, or exhaustion, there is little or no

water in the air-passages or stomach; the cavities of the heart and the large vessels are equally distended with blood, or are nearly empty, and the brain and internal viscera are in their natural state.

Death by concussion, asphyxia, apoplexy, or disease of the heart, reveals itself by the usual post-mortem appearances.

In mixed cases, the appearances due to asphyxia are less strongly marked. There is less froth at the mouth, less water and froth in the air-passages and stomach, less congestion of the lungs, heart, and great vessels, and internal viscera.

Several medico-legal questions suggest themselves in reference to a body found in the water. The first in order is the following; —*Was death caused by drowning?* In the case of a body found in the water, death may obviously have happened prior to immersion from natural causes, or from some form of violent death such as hanging, or strangulation, which gives rise to the characteristic appearances of asphyxia, so that we have to consider whether the post-mortem appearances alleged to be characteristic of death by drowning might have been occasioned by causes acting before immersion; and whether, in the case of bodies which have remained in the water some time, the appearances usually attributed to the mode of death may not be explained by the circumstances of the immersion itself.

It should be understood, then, that the position and swollen state of the tongue; the pallor, with rosy or violet discolorations of certain parts of the skin; the injected state of the brain; the congestion of the internal viscera; the fulness of the right cavities of the heart, and emptiness of the left; the fluid state of the blood; and the existence (very rare) of bloody urine in the bladder are appearances common to the several forms of death by asphyxia; while excoriations of the fingers, with sand or mud in the hollow of the nails; fragments of plants grasped in the hand; water in the stomach; froth at the mouth and nostrils; froth, water, mud, or sand in the lungs and air-passages; goose skin, and retraction of the penis, are characteristic of death by drowning.

So that of the appearances common to drowning and to death by other forms of asphyxia, all that can be said is, that their presence in persons found dead in the water is consistent with the supposition of death by drowning.

The post-mortem appearances alleged to be due to drowning, and to be characteristic of it, must now be briefly considered.

Excoriations of the fingers are much more often absent than present; but, when they exist, may be regarded as a probable,

though not certain, sign. They might be caused previous to forcible immersion, by the rubbing of the fingers against any hard and rough body; and possibly after death in running streams.

Sand or mud in the hollow of the nails, also affords a probability of immersion during life, for it implies, like excoriations of the fingers, that the drowning man grasped at the bed or banks. But if the body remained long in the water, mud or sand might be deposited in the nails.

Hands clenched and *grasping weeds growing in the stream or on the banks*, afford the strongest probability of death by drowning.

Water in the Stomach.—This also affords strong presumption in favour of death by drowning; especially if the water (or other fluid) can be identified with that in which the body was found by its containing leaves of plants growing on the banks or at the bottom. Except in the cases presently to be mentioned, it presupposes acts of deglutition during efforts to breathe. It is, however, possible, though very unlikely, that the water might have been swallowed a very short time before submersion.

The quantity of water depends partly on the number of respiratory efforts made during the act of drowning, and partly on the depth of the water. In animals stunned before immersion, as well as in those prevented from rising to the surface, the stomach contains no water; while in animals free to move it is found to be in proportion to the number of times they rise.

That the depth of the water also influences the quantity found in the stomach is proved by the experiments of Dr. Taylor. The stomach of a cat held two feet below the surface of the Thames contained scarcely any water; that of a cat lowered to the depth of fifty-five feet held a large quantity; while the stomach of a third cat allowed to rise repeatedly to the surface, held a quantity of water intermediate between the other two. The columnar pressure of the water is, therefore, considerable; and it is probable that when the water is very deep it may force the passage of the œsophagus, even though the animal died previously to submersion. But repeated experiments on animals have shown that, as a rule, water does not enter the stomach after death, not at least until the tissues have been relaxed by putrefaction.*

* The experiments of Liman (Casper's 'Handbuch,' vol. ii. p. 747, 5th edition), seem to throw considerable doubt on the value of the presence of water in the stomach as a sign of submersion during life. His experiments consisted in submerging the dead bodies of children in an artificial morass compounded of water and easily recognisable material. The bodies were placed in this, some with the face upwards, some quite submerged, and then taken out after a day or two by the head or feet, or in no definite manner. In 16 experiments the material was found in the stomach seven times, and in the œsophagus, pharynx, and trachea fourteen times. Neither the degree

It is obvious, then, that water in the stomach is not to be taken as conclusive of death by drowning, when the water is of great depth, or the body far advanced in putrefaction. It must also be admitted that the water might have been swallowed just before immersion, and possible, also, though most improbable, that it might, as suggested by Orfila, be maliciously injected after death.

On the other hand, the absence of water from the stomach must not be taken as evidence that the death was not caused by drowning; for it is not present in death by drowning due to causes other than asphyxia, such as shock, syncope, concussion, or apoplexy. The tendency to swallow may also be resisted; or the body may be, in some way or other, prevented from rising to the surface.

Again, water may have entered the stomach, and yet not be found there after death, if the head be allowed to hang down, as was proved by Dr. Taylor's experiments. Again, by long exposure after removal from the water, the fluid in the stomach may transude through its coats, and disappear.

Froth, Water, Mud, or Sand in the Air-Passages.—Mucous Froth.—From the experiments of Piorry and Orfila on animals, the presence of mucous froth in the air-passages was inferred to be due to the body rising repeatedly to the surface for air. In animals kept entirely under water no froth was found; and it was also absent when the body remained in the water a long time, or was subject to long exposure after its removal; as also when the head was placed downwards. But Casper, as the result of numerous observations, affirms that these experiments are not applicable to the human subject. He found froth in the trachea, equally in those who could, and those who could not, have risen to the surface.—(Handbook, vol. ii. p. 238.) The value of this evidence of death by drowning is also impaired by the fact that mucous froth exists not only in the several forms of death by asphyxia, but in death by apoplexy or epilepsy, and in catarrhal and other affections of the lungs.

Ogston* however, states that the mucous froth of drowning can be distinguished from frothy mucus due to other causes, by its whitish, rarely sanguinolent appearance, forming a kind of lather composed of minute bubbles, with a watery envelope easily ruptured.

of putrefaction, nor the length of time during which the bodies were allowed to lie in the morass, appeared to influence the result; nor did it matter whether the bodies were drawn out by the head or heels. He concludes from his experiments that the occurrence of water in the stomach or air passages may be purely a post-mortem accident.

* 'Lect. on Med. Jurisp.,' p. 508.

Water in the Lungs.—That water generally enters the lungs in death by drowning has been abundantly proved by experiments on animals, and by cases in the human subject in which sand and mud, and leaves of plants, have entered the air-passages. By drowning rats in chalk and water, with free access to the air, I have never failed to obtain effervescence by means of acids in every part of the lungs (G.).

But the value of this sign is impaired by the fact that water may enter the lungs of those who have been thrown in after death. Orfila and Piorry found that the quantity which thus gained admission varies according to the position of the body, being large when it remained upright, less when horizontal.

But water is not always present in the lungs in death by drowning; for, as in the case of the stomach, if the head is placed downwards the water flows out. Long exposure, too, will cause it to transude and be lost. The suggestion that water may be *injected* after death may be treated as a fanciful refinement.

Froth at the Mouth and Nostrils.—This, too, is a sign of death by drowning; but open to all the objections just stated in respect of froth in the air-passages. It has, indeed, a close dependence on the existence of froth in the air-passages, but it is always seen most copiously shortly after death. Contrary to the generally accepted belief that it appears sooner in summer than in winter, owing to its propulsion from the air-passages by development of gas, Ogston states that it appears sooner in winter than in summer. It rapidly disappears when the body is exposed to the air.*

Cutis anserina.—In death by drowning, whether in summer or winter, the body exhibits the appearance known as "goose-skin" or cutis anserina. This is caused by the contracted state of the *arrectores pili*, and is chiefly seen on the anterior surface of the extremities. The cutis anserina may, however, be found in death from other causes, and particularly in cases of sudden death with nervous excitement. Taken by itself, its presence does not prove death by drowning, but its absence would be a serious objection, unless other signs were unusually pronounced.

Retraction of the Penis.—Casper alleges that, in men who have fallen into the water alive, and died by drowning, he has almost never failed to find this appearance, while he has not observed it so constantly after any other kind of death.—(Handbook, vol. ii. p. 236.) It is not, however, universal.

From this examination of the signs of death by drowning, it appears that there is no one sign on which entire reliance can be

* 'Lect. on Med. Jurisp.' p. 598.

placed. But when several signs coincide, the probability is greatly strengthened. Some authors, Orfila among the number, have thought that the question, Was death due to drowning? admits of no decision; but from this opinion Devergie and Casper very properly dissent.

It should also be borne in mind that the most characteristic appearances are not permanent. In winter they may continue after the body has lain from fifteen to eighteen days in the water, but in summer they may disappear as early as the third day. Under exposure to the air they also rapidly pass away, and in the height of summer a few hours may suffice to dissipate them. Advanced putrefaction destroys all the signs of death by drowning.

The time that the body has remained in the water will be determined approximately by the signs laid down at p. 260.

The evidence derived from the signs of death by drowning admits of being confirmed or invalidated by the condition of the body in other respects, especially by the presence or absence of

Marks of Violence.—With regard to injuries on the bodies of persons found in the water, three questions arise:—

1. Were they inflicted during life? 2. If so, are they such as to account for death before submersion? 3. Were they accidental, suicidal, or homicidal?

The first and third questions are fully discussed under the head of wounds. The immersion of the body in water will influence the decision of these questions, only in so far as the injuries are thereby altered in appearance.

Are the Injuries such as to account for Death from Submersion?

There are five ways in which a body taken from the water may come to exhibit marks of violence. 1. A man may be murdered and thrown into the water dead; 2. He may receive severe injury from the hands of others or himself, and may then be thrown (or throw himself) into the water while still alive. If the injuries are in the shape of bruises, they may have been caused 3. By the death struggles; 4. By some obstacle against which the body is borne; 5. In the very act of falling into the water.

1. In a man who has been murdered and thrown into the water dead, we should expect to find all the signs of death by drowning absent, with the exception of such as may have been caused by uncommon depth of water, or advanced putrefaction.

2. On the supposition that a man found in the water had first been severely injured and then thrown in alive, we might expect to find signs of drowning proportioned in number and distinctness to the strength still left after the violence inflicted.

3. The bruises caused by the struggles of the drowning man would not be so severe or extensive as to endanger life.

4. The bruises caused by fixed obstacles, against which the body might be borne by a running stream, would not be strongly marked. It is not likely that such severe injuries as dislocations or fractures could originate in this way, unless the obstacle were in motion—*e.g.* a water-wheel, screw, or paddle.

5. *Falling into the Water.*—A person who falls or throws himself from a height upon a hard bank or pier of a bridge, may not only be severely bruised, but sustain such injuries as fractures of the skull or limbs, and extensive lacerated wounds.

Dislocation of the limbs is a possible consequence of falling from a great height. Many years since, as stated by Dr. Gordon Smith, a man who used to jump from the parapet of London Bridge into the Thames for a wager, and had previously performed the feat with impunity, sank and was drowned. Both arms were found dislocated, in consequence, it is thought, of his having fallen with them stretched out instead of close to his sides, as was his wont.

Two cases are also recorded (South's edition of Chelius's Surgery, vol. i. p. 532), the one of fracture of the body and arch of the fourth cervical vertebra, and the other of fracture of the body of the fifth vertebra, caused by jumping into the water. The deaths were attributed to a sudden retraction of the head to avert collision with the bottom.

We should, therefore, ascertain whether the drowned man fell from a height; whether the water is a rapid stream; and whether the body was found near obstacles fixed or in motion; and if there are no such causes as these to account for the injuries sustained, we may fairly trace them to some cause preceding the immersion. In bodies found in shallow still water, marks of violence afford strong presumption of homicide.

Assuming death to have been due to drowning, the question arises—

Was the Drowning the result of Accident, Suicide, or Homicide?—This question is exceedingly difficult to answer; for if there are no marks of violence on the body, it is not possible to say whether the man fell in, or jumped in, or was pushed in; and in respect of bodies found in running streams, it may not be possible to ascertain at what point they entered the water.

Nor, if we find the hands of the drowned man grasping leaves or grass, showing that he had struggled hard while in the water, can we affirm that he was thrown or pushed in by others.

Nor again, does the fact of a man being drowned in a shallow stream of water exclude the idea of homicide; for if a strong

man were to hold the head of a weak or infirm one in a basin of water, he might drown him as effectually as in a deep stream. On the other hand, cases of suicidal drowning in shallow water, or in narrow spaces, such as small house-cisterns, are on record.

It is evident, from what has been stated, that in the absence of marks of violence, we have no means of determining whether the drowning was due to accident, suicide, or homicide; and that such marks, to throw any light upon the question, must be such as could not have been inflicted by the drowned man himself prior to immersion, or by the accidental striking of the body against an obstacle in entering the water or during the death struggle.

There is one case which at first sight would seem conclusive of homicide, namely, where a body is found in the water tied hand and foot. Dr. Smith, however, relates the following case:—In July, 1816, the body of a gauging-instrument maker, who had been missing for some days, was discovered floating down the Thames. His wrists were found tied together and made fast to his knees, which were also secured to each other. He had been deranged for two years. The cord with which he had tied himself was recognised as that with which he used to raise himself in bed. He was a good swimmer, and probably adopted this means of disabling himself. The verdict was "Found drowned." Two similar cases are on record, one by Foderé, in which the hands and fingers were tied together with a silk riband in numerous folds; and another in which the feet, wrists, and neck were tied. Foderé in the one case, and the medical examiners (Marc, Guichard, &c.) in the other, gave their opinion in favour of suicide. In such cases as these it would be necessary to determine whether the knots or folds could have been made with the teeth, or by any movements of the hands or limbs.

Resuscitation from Drowning.—The insensibility which supervenes on asphyxia brought about by obstruction of the respiration, is not synonymous with death, for though all spontaneous respiratory movements have ceased, resuscitation is possible so long as the heart continues to beat.

As, then, in such cases of obstructed respiration, the heart may continue to beat for several minutes after every respiratory movement has ceased, all hope of resuscitation need not be abandoned though no respiratory movements can be perceived. But in asphyxia produced by drowning, even though the heart may continue to beat, resuscitation can rarely be brought about after complete submersion lasting for so short a period as two minutes, or even less than this. The cause of this difference is the entrance of water into the lungs, which renders them incapable of collapsing

and aerating the blood by the methods resorted to. Many cases of resuscitation after submersion for a longer period are on record. Some of these may be discarded as untrustworthy, and ascribed to exaggeration of time by anxious onlookers. Others, however, may be referred to the supervention of syncope at the moment of immersion, in consequence of which the aspiration of water into the lungs has not occurred to any extent; and some perhaps to the success attending the first efforts made to free the lungs from water.

In the treatment of the drowned, or of asphyxia in general, recourse must be had to *artificial respiration.* But the special circumstances of drowning require that means be used to counteract the great loss of heat which occurs even in the greatest summer temperature, and also precautions to remove from the air-passages the accumulated mucus and fluids which obstruct them.

The following rules for the treatment of the drowned are in accordance with the method of Dr. Henry Silvester, which has now, by general consent, taken the place of that recommended by Dr. Marshall Hall. Send immediately for blankets and dry clothing, but treat the patient instantly on the spot, in the open air. First place the body, for a few seconds, with the face downwards, the head lower than the feet, the mouth open, and the tongue drawn forward; then turn the body on the back, place it on an inclined surface, raise the shoulders and support them, and fix the feet. Now grasp the arms at the elbows, draw them above the head, and keep them on the stretch for two seconds, then reverse the movement for the same length of time, pressing the arms firmly against the sides of the chest. Repeat this twofold movement fifteen times in the minute, till a spontaneous effort at respiration occurs. Then remit the movements, and proceed to promote the circulation and restore warmth by firm friction and pressure directed upwards, by hot flannels, hot bottles, bladders of hot water, or heated bricks; or borrow warm clothing from the bystanders. Respiration may be promoted by smelling salts, tickling the throat with a feather, and by the alternate dash of cold and warm water on the face and chest. When the respiration is restored, warm brandy and water, wine and water, tea or coffee, may be given; and the patient being put to bed, should be allowed to sleep. Our efforts to restore life should be persevered in for three or four hours, or till some certain sign of death has shown itself.

Howard's Method of Artificial Respiration.*—Howard recom-

* The Direct Method of Artificial Respiration: 'Trans. Amer. Med. Ass.' Vol. xxii. 1871.

mends that the accumulated fluids should first be got rid of by placing the body in a prone position, with a roll of clothing beneath the stomach, and pressing on the spine till this is effected. The body is then laid supine with a roll of clothing in the hollow of the back, so as to render the epigastrium prominent. The arms are drawn upwards, held by the hand of an assistant, whose other hand is employed in keeping the tongue drawn out at the corner of the mouth with a cloth. The operator then kneels astride or at the side of the patient, places his hands on the short ribs, then pivoting himself on his knees throws the weight of his body forward on the hands, which at the same time squeeze the chest walls. He then lets go suddenly, so as to allow an inspiration, and this alternate compression and relaxation is to be carried out about fifteen times per minute.

DEATH BY HANGING.

In the year 1871, 548 persons perished by hanging, in England and Wales, of whom 448 were males and 100 females. All these deaths were ascertained suicidal acts.

As asphyxia is a cause of death, common to hanging, strangulation, and suffocation, a few observations will be made on these modes of death before proceeding to examine them separately.

Though it is usual to say of death from these three causes that it is due to *suffocation*, this term has in medico-legal language a distinct meaning of its own. It means death caused by some impediment to the respiration, which does not act by compressing the larynx or trachea. Thus a man is said to be suffocated if his mouth and nostrils are closed, or if he is prevented from breathing by pressure on the chest or abdomen. Certain noxious gases, too, are said to kill by suffocation. This subject, then, separates itself from those forms of death (hanging, strangulation, and throttling) in all of which pressure is exercised on the *air-tube* and *throat*.

The most simple cause of death is *throttling*, or direct pressure on the trachea with the fingers. Here the cause is obvious; it is the same as in many cases of drowning; the same as in suffocation—viz., *asphyxia* (apnœa). Death takes place from the mechanical hindrance to respiration. But the cause of death is not so clear when the entire circumference of the neck is subject to pressure; for then not only the larynx or trachea, but the blood-vessels also suffer. In some instances both air-tubes and blood-vessels are implicated; in others the air-tubes suffer compression and the vessels escape; in others, again, the air-tubes

escape and the vessels sustain the pressure. The respiration and circulation are most completely impeded when a cord is fixed round the lower part of the neck, so as to embrace the trachea and the large vessels at their entrance into and exit from the chest; or when it is applied, or drawn by the weight of the body, beneath the lower jaw. Both functions are less interfered with when the cord is fixed directly over the larynx, as the projections of the os hyoides and thyroid cartilage afford some protection to the windpipe and blood-vessels.

This variation in the position of the ligature, and in the consequent pressure on the organs of respiration and circulation respectively, explains the difference in the time required to destroy life in all those cases in which death does not take place instantaneously from shock or injury to the spinal cord; and the simultaneous compression of the air-tube and blood-vessels gives rise to the question, whether the pressure on the air-tube or on the blood-vessels is the immediate cause of death. In other words, is death caused by asphyxia or by coma?

It was formerly the general belief that death was due to *coma*; and this opinion was not unreasonable, for it is well known that mere pressure with the fingers on the carotid artery will cause sleep, by checking the supply of blood to the brain, and that apoplexy is often brought on, in persons predisposed, by the pressure of a cravat impeding the return of blood through the veins. That coma, therefore, may be brought about by pressure on the large blood-vessels is not to be doubted, but the question still recurs—in those cases of suspension or strangulation in which the air-tube and blood-vessels are simultaneously compressed, which of the two pressures causes death? Both causes doubtless contribute to the fatal result, but the stoppage of the respiration is certainly the essential cause; for death by asphyxia would be much more speedily and certainly induced by a complete or partial stoppage of the breathing, than fatal coma by the complete or partial arrest of the circulation. But an appeal may be made to actual experiment for the decision of this question. A dog was suspended by the neck with a cord, an opening having been made in the trachea below the place where the cord was applied. After hanging about three-quarters of an hour, during which time the circulation and breathing went on as usual, the animal was cut down, and did not appear to have suffered much. The cord was then shifted below the opening, so as to stop the ingress of air into the lungs; and the animal being again suspended, was in a few minutes quite dead.* In this ex-

* 'Cyclopædia of Practical Medicine,' Asphyxia.

periment the compression was less than it would be in many cases of death by hanging in the human subject, in which the violence employed, the height of the fall, and the weight of the body combine to tighten the cord, and thus exercise the strongest pressure on the vessels as well as on the air-tube.

A similar operation has been performed on the human subject.* "A man of the name of Gordon was executed at Tyburn, in April, 1733. Mr. Chovet having by frequent experiments on dogs, discovered that opening the windpipe would prevent the fatal consequences of the halter, undertook to save Gordon, and accordingly made an incision in his windpipe, the effect of which was, that when Gordon stopped his mouth, nostrils, and ears for some time, air enough came through the opening to allow of the continuance of life. When hanged, he was observed to be alive after all the rest were dead; and when he had hung three-quarters of an hour, being carried to a house in the Tyburn road, he opened his mouth several times and groaned; and a vein being opened he bled freely." But these were the only signs of life. Smith attributed the want of success to the great weight of the man, coupled perhaps with the insufficiency of the opening into the trachea.

It appears, then, that when the windpipe and the large blood-vessels suffer compression, death may be attributed to asphyxia; that when the respiration is free, or but slightly affected, pressure on the vessels may cause death by coma, but more slowly; and that when respiration and circulation are both impeded, both may contribute to the fatal result, though the hindrance to the respiration is the more efficient.

It has been suggested that the immediate cause of death in hanging and strangulation is pressure on the nerves which subserve the function of respiration; but as such pressure does not prove fatal till the lapse of many hours, this explanation must be rejected.

Having now examined the questions common to death by hanging and by strangulation, the subject of death by hanging may be resumed.

Death takes place very suddenly in certain cases of suspension, as in some cases of drowning, either from shock or syncope, or from injury to the spinal cord by luxation of the cervical vertebræ, fracture of the odontoid process, or rupture of the intervertebral substance; these injuries to the spine being caused either by the fall of the body from a height, or by a rotatory motion given to the body at the moment of the fall.

* Smith's 'Forensic Medicine,' Appendix, p. 561.

Death by hanging takes place, then, in different ways and at different intervals of time. The quicker deaths may be traced to injury of the spinal cord above the origin of the nerves of respiration, and, more rarely, to syncope. Next in rapidity is death from asphyxia, and the least rapid that by coma.

We are not without information as to the sensations that accompany death by hanging. Suicides saved from death, and philosophers who have instituted experiments on themselves, have both contributed something to our knowledge. It appears that these sensations are not always the same; and the difference probably depends on the various degrees in which the windpipe and blood-vessels are compressed. Some have retained no recollection of what happened; others were conscious of sudden loss of sense and motion; in others a deep sleep was ushered in by flashes of light, by a bluish flame, by brilliant circles of colours, or by more definite ocular illusions, accompanied by hissing or singing in the ears. In other instances the sensations are stated to have been extremely pleasurable, though of short duration. These sensations resemble those that are caused by disordered cerebral circulation, and those that usher in the fits in some cases of epilepsy. But it is only in cases of suicide that these pleasurable sensations manifest themselves. In homicidal cases, especially, when much violence is used, there are signs of great suffering.

Appearances after Death.—The eyes are brilliant and staring, and seem to be bursting from their sockets; the eyelids open and injected, and the pupils dilated; the tongue, swollen and livid, is forced against the teeth, or more or less protruded from the mouth, and compressed or torn by the contracted jaws; the lips are swollen and the mouth distorted; and blood, or a bloody froth, hangs about the mouth and nostrils; the arms are stiff, the hands livid, and the fingers so forcibly closed on the palm as to force the nails into the flesh; and the convulsions are so violent as even to cause the expulsion of the contents of the bowels, and to produce erection of the penis, with discharge of the urine, semen, or prostatic fluid. The circumscribed rose or violet discolorations of the trunk and extremities common to all cases of death by asphyxia are strongly developed; the course of the cord is distinctly indicated by a well-marked bruise, or by some of the appearances presently to be described; and, on dissection, the muscles and ligaments of the windpipe are found stretched, bruised, or torn, and the inner coats of the carotid arteries sometimes divided; and, more rarely, there is fracture or dislocation of the cervical vertebræ and injury of the medulla.

The *internal* appearances are those of asphyxia (see p. 267) or

of asphyxia with marked cerebral congestion. Cerebral hæmorrhage is extremely rare. In some cases intense congestion of the mucous membrane of the stomach, simulating irritant poisoning, has been found. Where death has resulted from shock or direct injury to the medulla, the signs of asphyxia will be wanting.

Two principal medico-legal questions arise in regard to persons found hanged. 1. Did the suspension take place during life, or after death? and, 2. Was the hanging accidental, suicidal, or homicidal?

1. *Did the suspension take place during life, or after death?* The points most worthy of attention as bearing on the solution of this question are :—*The mark of the cord; The appearance of the countenance; The position and state of the tongue; The condition of the genital organs;* and, *The expulsion of the fæces.*

Mark of the Cord.—The appearances on the neck due to suspension during life are not uniform. In homicidal cases, the neck sustains great injury, the skin is bruised, and the subjacent parts torn; but in judicial and suicidal hanging much less injury is done both to the skin and to the deeper-seated parts.

In those cases (both judicial and suicidal) in which the position of the cord is mainly determined by the weight of the body, it follows pretty closely the line of the jaw-bone, and there may be an oblique indented mark, of the colour of a recent bruise, on the fore part of the neck, and yellowish-brown, as if from a singe, towards the angle of the jaw. The bruise may correspond with the whole breadth of the ligature; or there may be a deep groove, bordered by two discoloured lines. The mark varies with the size and texture of the cord, being less distinct when a soft material, such as a handkerchief, is used, than when a hard ligature, such as a rope, is employed. When the material is hard and resisting, the number of times that the ligature has been passed round the neck, and the material of which it consists, are clearly displayed. But in many cases of judicial and suicidal hanging, the mark of the rope consists at first of a simple depression without any change of colour, oblique if due to the weight of the body, horizontal if firmly fixed round the neck. After the lapse of several hours, the rope-mark assumes a light-brownish tint, and if an incision be made into the skin, the cellular tissue is found strongly compressed, so as to form a shining white band. Occasionally injection of the skin at the bottom of the groove is found, or even minute ecchymoses of the *cutis vera* (Neyding and Bremme). Sometimes the pressure is lessened by the beard, or it is not equal on the two sides, or the back of the neck escapes. The face, as will be presently more fully stated, is at first pale and its expres-

sion natural, and it is not till several hours have elapsed that it grows livid, and still longer before it wears a bloated appearance.

In a case of judicial hanging, in which the cord was removed soon after the body had been cut down, we observed merely a depressed circle on the fore part of the neck, and a slight excoriation, with a burnt appearance, over the angle of the jaw. In a case of suicidal hanging with a small rope tied firmly round the neck, but removed without delay, there was a white depressed line deeper at the back of the neck than in front, and assuming a dusky hue after several hours. The strands of the rope were distinctly marked, but there was no ecchymosis on any part of the neck. In another case of suicidal hanging a hard depressed chocolate-coloured band completely surrounded the neck, and corresponded to the rope of coir which had been used (G.).

In cases, then, of hanging during life, the cord does not always produce the same appearances. In some cases there is a well-marked bruise or ecchymosis, in others a pale indentation and a condensed state of the subcutaneous tissues, resembling old parchment; in others, again, a hard chocolate-coloured groove; and these marks, limited to the fore part of the neck, may be combined at the angle of the jaw with a singed appearance. The cuticle may also be abraded here and there.

Can the appearances occasioned by the cord during life be produced after death?—This question has been answered in the affirmative. In the chapter on Wounds and Mechanical Injuries

Fig. 34.

it will be shown that bruises may be produced some time after life is extinct; and that which is true of bruises in general wil

of course hold good with respect to this particular form of bruise. Accordingly Orfila proved, by experiments on the dead body, that up to eighteen hours after death, precisely the same appearances may be produced as in suspension during life; Devergie has produced the parchment-like condition of the skin and subjacent cellular tissue, as well as the livid appearance bounding the depression; and Casper sums up the results of a long series of experiments by the remarkable statement "that any ligature with which any body may be suspended or strangled, not only within a few hours, but even days after death, especially if the body be forcibly pulled downwards, may produce a mark precisely similar to that which is observed in most of those hanged while alive;" and he adds that he has been convinced by his experiments that *the mark of the cord is a purely cadaveric phenomenon.* (Handbook, vol. ii. p. 173.)

Fig. 35.

But for these confident statements of Casper, based upon several experiments and large experience, I should have attached some value to the depressed chocolate-coloured line which I encountered in one case of suicide, accompanied by so condensed a condition of skin that, when cut, it resembled closely the toughest brawn. The appearance of the neck is well shown in the engraving (fig. 34) from a photograph, which also displays the results of an experiment made with the cord used in the suspension, fastened tightly round the neck within an hour of the death, and left for about 20 hours. The result was a slightly depressed mark the size of the cord, showing the projecting strands in white depressions, on a faint rose-coloured ground. This mark did not deepen in colour by exposure. The deep indigo blue colour of the ears was very remarkable, though the man had a swarthy complexion.

The suicide had attached a neckerchief to a hook, and passed through the loop the small rope of coir by which he hanged himself. He had mounted a table which he kicked from under him. His feet nearly touched the floor of the cell. (Fig. 35.) (G.)

But even in cases in which the mark of the cord is indistinct and not in itself conclusive, the state of the parts beneath the skin may enable us to speak with confidence. A considerable effusion of blood, a rupture of the trachea, a separation of its cartilages, a dislocation of the spine, a division of the coats of the vessels, all of them evidence of great violence, would furnish a strong probability of suspension during life, or of suspension after forcible strangulation.

The face.—In death by hanging, whether judicial or suicidal, the face is usually pale, and its expression natural. But the pallor is followed, after a few hours, by a livid hue of the lips, eyelids, ears, and face generally; and, after a still longer interval, by a marked congestion of the face. There is nothing in the expression or colour to show whether suspension took place during life or after death, but if the vessels of the head and face are found highly congested in a body recently cut down, there is a probability of suspension during life; for suspension after death, though it might produce discoloration of the neck, could not cause turgescence of the vessels of the head and face.

Position and State of the Tongue.—The same injected and swollen state of the base of the tongue, with or without protrusion, which occurs in other forms of death by asphyxia, occurs also in death by hanging, and affords a strong probability of suspension during life.

State of the Genital Organs.—The genital organs of both sexes are affected in death by hanging. In the female, redness of the labia and discharge of blood have been noted, and in the male a more or less complete state of erection of the penis with discharge of urine, mucus, or prostatic fluid, is present in at least one case in three. There may also be discharge from the urethra without erection. But these appearances in the genital organs, when they do occur, are not characteristic of death by hanging or strangulation, for they have been seen in other forms of violent and sudden death, as in fatal gun-shot wounds of the brain, and of the large vessels, and in poisoning by prussic acid.

This sign then, when present, is very important; for it is strictly vital, and affords a sure proof of violent and sudden death; and, if combined with characteristic external signs and internal appearances, of death by hanging. On the other hand erection and emission may be absent, and yet death may have been due to this cause.

Expulsion of the Fæces.—This happens in about one-fourth of the cases of death by hanging, but as it also occurs in other

forms of sudden or violent death, it needs to be confirmed by characteristic appearances, external and internal.

2. *Accident, Suicide, or Homicide.*—Accidental hanging is very rare. One case is given by Gordon Smith:—It was that of a girl who was swinging in a brewhouse, near a rope used for drawing up slaughtered sheep. Her head got through a noose of this second rope by which she was pulled out of the swing, and kept suspended till she died. Dr. Taylor also relates a case communicated to him by one of his pupils:—A boy ten years old fastened a piece of plaid gown to a loop in a cord suspended from a beam, and in the act of swinging raised and turned himself, when the loop of rope caught him under the chin, and suspended him till life was extinct. A playmate witnessed the occurrence.

Setting aside a few such cases, which can create no difficulty, the question under consideration is narrowed to this: *Was the hanging suicidal or homicidal?* The figures of the Registrar-General show that the probability is always strongly in favour of suicide; and, for obvious reasons, hanging is a mode of death a murderer is not likely to select. It presupposes a great disproportion of strength between him and his victim, or a combination of two or more persons against one. The solitary ascertained case of homicide in the five years 1852 to 1856, was committed on a young child.

There would be nothing in the appearance of the body itself, beyond the marks of a severe struggle, to distinguish the homicidal from the suicidal act; but if a man were found suspended at a height from the ground which he could not by any possibility have reached, and with no object near on which he could have mounted, we must conclude that he was suspended by another.

It was once thought that a man found with the feet, or some part of the body, touching the ground was more likely to have been hanged by another than by himself; but this has been shown to be an error, for undoubted suicides have been found, not only with the feet touching the ground, but with the knees bent and raised above it or in such postures that death must have been caused by leaning forcibly forward and so compressing the windpipe.*

As in most of these cases the cord would not be drawn by the weight of the body into the usual oblique position, such cases would differ from cases of strangulation only in the mark being less distinct, and embracing a smaller portion of the neck.

* A great many cases, in which the bodies of suicides were found placed in every possible attitude, are given, illustrated by engravings, in an interesting paper in the fifth volume of the 'Annales d'Hygiène.'

The marks of violent struggles on the clothes or person of the deceased would justify a suspicion of homicide; but as severe and extensive injuries have been known to be produced by a suicide, and slighter injuries may take place accidentally, this criterion must be used with caution.

We must add that persons found suspended have been previously killed by strangulation or other violence, and by poison.

DEATH BY STRANGULATION.

This mode of death is rare compared with death by hanging. It accounts for about 50 deaths a year, of which 37 are males and 13 females. Half these deaths are suicidal; of which 20 in males and 5 in females. Homicide by strangulation, though much more common than by hanging, is rare in adults, but common in children.

Strangulation differs from hanging only in the fact that the body is not suspended; but some cases of suicidal hanging in which the body touches the ground would be rightly set down to strangulation.

Strangling is usually effected by the uniform pressure of a ligature round the neck; but occasionally some hard substance is introduced into the folds of the ligature, and placed over the windpipe.

The mark on the neck will differ accordingly in the two cases, being oblique and high up in death by hanging, circular and low down in death by strangulation. From this rule, however, we must except those cases of hanging in which the cord is firmly fixed, and those in which the body touches the ground; and those rare cases of strangulation in which it happens that the ligature is fixed somewhat obliquely. The mark in hanging, therefore, may happen to be circular, and that in strangulation more or less oblique. A foreign body in the folds of the ligature would be indicated by the greater size and distinctness of the bruise over the windpipe.

Another difference between the two modes of death is, that in strangulation much more force is used; rendering the mark on the neck more distinct, and the injury to the subjacent parts greater. This will be especially the case in homicidal strangulation, for the murderer generally uses unnecessary violence.

Frequently, also, there are wounds and bruises of other parts of the body indicative of struggling; and to the same cause are to be attributed certain appearances described by Tardieu as occurring in strangulation more frequently than in any other form of asphyxia. These are punctated ecchymoses on the conjunc-

tiva, face, neck, and upper part of the chest; and interstitial emphysema due to rupture of some of the superficial air-cells of the lungs. Sometimes also apoplectic extravasations are found on the surface of the lungs of much larger extent than the capillary ecchymoses which occur more particularly in simple suffocation.

The same questions arise in respect of strangulation as of hanging—viz., 1. *Was death caused by strangulation?* 2. *Was the strangulation accidental, suicidal, or homicidal?*

1. *Was Death caused by Strangulation?*—A cord applied a few hours after death would not produce so much bruise as would result from its application during life; and the turgescence of the face and characteristic post-mortem appearances would be wanting. It is only, therefore, in suicides, and in the scarcely conceivable case of slight force being used by the murderer, or death taking place suddenly, from shock or syncope, that the appearances produced by a cord applied during life could resemble those due to its application after death; and the same is true of direct pressure on the windpipe. As, moreover, hanging is known to be a common suicidal act, the murderer is not likely to simulate strangulation in order to hide the real mode of death. It is much more likely that having strangled his victim, he would attempt concealment by suspending the body or placing it in a position suggestive of suicide.

In the well-known case of Bartholomew Pourpre, the deceased was first strangled and then suspended, and the mark of the cord was found at the lower part of the neck, while the teeth knocked in, and the bloody mouth, showed the violence that had been used.

The murderers of Sir Edmondbury Godfrey, after strangling him near Somerset House with a twisted handkerchief very forcibly applied, hid the body for a time, and then carried it to Islington, threw it into a ditch, passed his own sword through him, and laid his gloves and other articles of dress on the bank, so as to create a belief that he had committed suicide. The absence of blood from the wound, though the sword had passed through the heart, excited suspicion, which was fully confirmed by the discovery of a bruise, an inch broad, extending round the neck, and a fracture of the cervical vertebræ, which rendered the neck so flexible that it could be turned from one shoulder to the other. The face, which during life was remarkably pale, was livid and suffused, and the eyes bloodshot.

2. *Accident, Suicide, or Homicide.*—That strangulation, like hanging, may be accidental, is proved by the following cases:—

An ingenious young man having nearly lost the use of his arms

used to move a heavy weight by a cord passed round his neck. One morning, soon after he went to his room, his sister found him sitting in a chair quite dead, with the cord twisted round the neck. The deceased must have tried to move the weight in the usual way, but it had slipped behind, and so strangled him. (Smith.)

In July, 1839, Elizabeth Kenchan, an extremely dissipated, drunken, and disorderly woman, went to bed intoxicated, with her bonnet on, and in the morning was found strangled in its strings. She had fallen out of bed, her bonnet became fixed between the bedstead and the wall, and she, being too drunk to loosen the strings, was strangled.

In a few cases, then, death by strangulation has been accidental; but if death did not take place in this way, the question is narrowed to the alternative of—

Suicide, or Homicide.—Strangulation appears to be a suicidal act in about half the recorded cases. As it is hard for a man to strangle himself by the pressure of his own hands, even if aided by a ligature, he resorts to twisting. In one case (Orfila), two cravats were twisted several times round the neck; in another (Dunlop), a Malay used a small stick for the purpose; in a third case, the handle of a pot was used. In the year 1838 a Mr. Watson, aged 88, strangled himself by placing a poker through the tie of his neckerchief and turning it round and round.

Strangulation by pressure of the hand on the trachea (throttling) may be safely assumed to be homicidal. A robust man seized another by the cravat, and pressed him firmly against a wall till he was dead. The face was found livid and swollen, and the features distorted; and there was considerable discoloration and depression at the seat of pressure. There were witnesses to the act, and the man was proved to be insane. (Case at the Chester Assizes, April 1835.)

An unsuccessful attempt to attribute death to accidental throttling was made in 1763, in the case of Beddingfield. He was found dead in his bed-room, lying on his face on the floor, with one hand round his neck, and his wife and manservant were charged with the murder. The medical testimony was very unsatisfactory, as no dissection had taken place, but it was proved that there were marks on the neck resembling those of fingers. One surgeon said there were marks of a thumb and *three* fingers; the other of a thumb and *four fingers:* while another witness saw only *two,* "which looked as if the blood was set in the skin." One of the criminals after condemnation confessed that he had seized Beddingfield's throat with his left hand as he lay asleep;

and that though he struggled violently and made some noise, he soon accomplished his purpose.

The appearances caused by throttling, when great resistance is offered, may be inferred from the evidence of Mr. W. Wilson in the case of Hector M'Donald, convicted of the murder of his wife, at Inverary, April, 1857. There was an abrasion on each side of the windpipe, five abrasions on the left, and three on the right arm; and the skin on the front and sides of the neck, and on the upper part of the chest was blackened. On the throat were the marks of a thumb and three fingers. It was inferred that the throat had been grasped by the left hand, of which the wrist was pressed upon the chest, and that the right hand had grasped the left arm of the victim. The internal appearances were highly characteristic of death by asphyxia. The substance and membranes of the brain were injected; the lungs and right side of the heart contained a quantity of dark fluid blood; the left was nearly empty. All the internal viscera were healthy.

The following is a case of homicidal strangulation by a foreign body introduced into the ligature;—Dr. Clench, a London physician, was called out of bed by two men on the night of the 4th of January, 1692, to visit a sick friend. He entered a hackney coach with them, and was driven about several streets in the City for an hour and a quarter. The men then left the coach and sent the driver on an errand. When he returned he found Dr. Clench sitting on the bottom of the coach, with his head on the cushion of the front seat. Thinking him in liquor, he shook him, but obtained no answer. He then called the watch, and they found him strangled by a coal wrapped in a handkerchief, and applied directly over the windpipe. The coachman had heard no noise while driving the carriage.

DEATH BY SUFFOCATION.

Under this head are comprised all cases of asphxyia not produced by direct pressure on the windpipe, with the exception of drowning which has already been treated separately.

In the year 1871, 1,504 deaths by suffocation occurred, of which 876 were in males, and 628 in females. In this number are comprised a large number of infants killed by overlying, or suffocated by bed-clothes, and others suffocated by their food, or by gases, chiefly charcoal vapours.

Suffocation may take place in many ways.

1. *The mouth and nostrils may be stopped* accidentally or by force. A person in a state of helplessness, from whatever cause,

may fall on the face and be suffocated by water or loose earth; and new-born children by the discharges, by the bed-clothes, or by being overlaid. Suffocation by such forms of pressure is also a homicidal act.

2. *Mechanical Pressure on the Chest.*—This may be accidental, through the fall of earth or rubbish; or homicidal, the murderer pressing with his whole weight on the body, and at the same time, compressing the windpipe with the hand; or pressing on the chest and closing the mouth and nostrils. Suffocation by pressure on the chest constituted part of the *peine forte et dure* of our ancient law. A risk of accidental suffocation by compression of the chest has been incurred in taking casts with plaster of Paris.

On the 14th of June, 1837, twenty-three persons lost their lives in a crowd in the Champs de Mars, some deaths being due to suffocation, others to severe injury to the chest.

3. *Closure of the Glottis.*—This also may be accidental, as in suffocation by food. When this happens in adults they are usually intoxicated, or in a fit. Thus Paris and Fonblanque quote the case of a patient who died in an epileptic fit after a heavy meal of pork, and the trachea contained a quantity of matter resembling the pork on which he had recently dined. This form of suffocation is not an uncommon termination of the general paralysis of the insane.

Accidental suffocation by small objects finding their way into the windpipe is not uncommon. The death of Anacreon, attributed to a grape-seed; that of Gilbert the poet to a piece of mutton; a case in which a piece of potato-peel was found impacted in the rima glottidis are cases in point. Of suffocation by irritating substances we have examples in a case of swallowing a bee in some honey; and another from slaked lime getting into the larynx. Small morbid growths, and the products of inflammation, have often sufficed to close this narrow passage.

Suffocation has also been often threatened and sometimes brought about by bodies impacted in the upper part of the gullet. Slaves, both in ancient and modern times, are alleged to have swallowed their tongues. Some articles of dress, such as a handkerchief, have been swallowed, and one determined suicide caused a fatal hæmorrhage by swallowing a cork bristling with sharp pins. The preparation is in the museum of King's College.

Suicidal suffocation by the vapours of charcoal are not common in England but very frequent in France.

Suffocation is not often a homicidal act, at least, in young and vigorous adults; for the force required is such as to reveal the cause of death by external marks and internal appearances; but

when the body is very weak from any cause, as in the new-born infant, the old man, or the intoxicated, suffocation is not difficult to effect, and if not attended by great violence, might not betray itself by external or internal marks.

The *post-mortem appearances* present in well-marked cases of death by suffocation are those of asphyxia. In the twenty-three persons suffocated in the crowd in the Champs de Mars M. Ollivier found without exception the skin of the face and neck of a uniform violet tint, spotted with blackish ecchymoses. In nine, the eyes were bloodshot; in four, a bloody froth ran from the mouth and nostrils; in four, blood flowed from the nostrils, in three, from the ears; seven had fractures of the ribs; and two, females, fracture of the sternum. In sixteen bodies that were opened, the blood was black and fluid, and filled all the large veins at the right side of the heart. The pulmonary tissue was mostly reddish-brown, and in three quarters of each lung, posteriorly, there was a considerable accumulation of black and liquid blood; but there was no ecchymosis, either on the surface or in the substance of the lungs, except in one case. In all the cases in which the eyes were bloodshot, and in those in which blood flowed from the ears, the vessels of the pia mater and substance of the brain were gorged.

State of the Lungs.—In death by suffocation, especially in infants, emphysema, and punctiform ecchymoses are common appearances.

In most cases the surface of the lungs instead of being smooth, is uneven or tuberculated, from partial vesicular or interstitial emphysema. A section into one of these patches shows that the parenchyma of the lung is affected.

The punctiform ecchymoses (Tardieu's spots) are found most commonly in children who have died of suffocation, but they may also occur in adults. They are minute spots on the pleura (visceral and costal), not confined to the surface of the lungs, for they may be observed on the thymus, the aorta, the heart, or the diaphragm; also on the surface of the abdominal viscera, and on the inner surface of the scalp. The surface of the lung looks as if it had been sprinkled with minute drops of a dark purple fluid. They are due to the rupture of the over-distended capillaries, and occur, according to Lükomsky, when the general blood-pressure is greatly increased by continued efforts to expire. Tardieu thought that they were diagnostic of death by suffocation as distinguished from other modes of death by asphyxia. but this opinion lacks confirmation, for they occur whenever a similar relation between the respiratory movements and the

blood-pressure exists, and have been found in hanging, drowning, and suffocation, and in death from cerebral injuries. It seems, however, to be generally admitted that they occur most commonly in children killed by suffocation, and Ogston* is of opinion that their occurrence on the thymus, in clusters rather than singly, is strongly in favour of death by suffocation. They occur in the fœtus, from interruption of the placental circulation; and they are common in the lungs of new-born infants (see Fig. 20, p. 105). They indicate death from asphyxia, but not the way in which it was brought about.

The slight injuries caused by the suffocation of helpless people led to the selection of this mode of death by the persons engaged in the supply of bodies to the anatomical schools prior to the passing of the Anatomy Act. Burke, with his female accomplice, Macdougall, was tried at Edinburgh, in 1828, and Bishop, with Williams and May, in London, in 1831.

Burke killed Margery Campbell, by sitting on her body, covering the mouth and nostrils with one hand, and applying the other forcibly under the chin.

Fifty-nine hours after death, the eyes were closed; the features composed, as in deep sleep, red, and somewhat swollen; the lips of a dark colour; and the eyes bloodshot. There was a little fluid blood on the left cheek, apparently from the nostrils; the tongue was not protruded or torn, but there was a slight laceration on the inside of the upper lip opposite the left eye-tooth; the cuticle under the chin was much ruffled, and the surface of the true skin, when laid bare, was dry and brown; but there was no bruise. The integuments, except on the face, were perfectly free from lividity. The joints were flaccid. There was no effusion of blood or laceration of the parts round the windpipe, and no injury of the cartilages, but the os hyoides and thyroid cartilage were further apart than usual. The following were the internal appearances: The membrane of the windpipe healthy, with here and there some tough mucus, not frothy, and a few bloody points between it and the membrane. The thoracic organs perfectly natural; the lungs remarkably so. The blood throughout the body black and fluid, and accumulated in the large veins, and in the right cavities of the heart. The abdominal viscera, with the exception of incipient disease of the liver, healthy. The brain also was quite healthy, and somewhat more turgescent than usual; and there were three extravasations of blood in the scalp, but without corresponding external bruise. There were some marks of violence on the

* 'Lect. on Med. Jur.,' p. 554.

limbs, considerable effusions of blood among the muscles of the neck, back, and loins, and on the sheath of the spinal cord. The posterior ligaments connecting the third and fourth cervical vertebræ were torn. A "handful" of clotted blood was found near the body.

In Carlo Ferrari, the victim of Bishop, the appearances from which suffocation might have been inferred were even less strongly marked. The face, it is true, was swollen and congested; the eyes bloodshot, and the lips tumid; but the lungs were quite healthy and not congested, the heart contracted, and all its cavities quite empty. But these exceptional appearances were explained by the fact that the murderers, after stupefying their victim with liquor, lowered his body into a well, head downwards, keeping the mouth below the water. In this case, too, there was some extravasated blood under the scalp, among the muscles of the neck, and on the spinal cord. The fresh state of the body, the appearance of the countenance, and a wound on the left temple, combined to excite suspicion, and led to the committal and conviction of the murderers.

In both these cases death was certainly caused by suffocation, and yet the appearance of the bodies was not such as to lead at once to the conclusion that death had happened in this way. The medical examiners in both cases were inclined to ascribe the deaths to the injury done to the spine, which was afterwards proved to have been occasioned after death by the forcible doubling up of the bodies in packing them.

In allusion to the opinion that the signs of suffocation are so strongly marked as of themselves to arrest attention, Christison speaking of the woman Campbell, says that "no person of skill, who had been told that murder was probable, but the manner of death unknown, could have failed to remark signs that would raise a suspicion of suffocation. But if he had not known that suspicions were entertained, he might have inspected the body even minutely, and yet neglected the signs in question. Every one conversant with pathological anatomy must be familiar with similar appearances, as arising from various natural diseases; and they were present in the body of a man who died of dysentery, the "vascularity of the conjunctivæ and the contusions on the legs" being "the o[illegible] difference."*

* Cases and Observations in Medical Jurisprudence: 'Ed. Med. and Surg. Journal,' vol. xxxi. 243. (1829.)

CHAPTER III.

WOUNDS AND MECHANICAL INJURIES.

THIS Chapter treats all injuries inflicted by mechanical means, except the several forms of death by suffocation examined in the previous chapter, and injuries by fire and by lightning, reserved for separate examination in Chapter VI.

All injuries, therefore, which one man inflicts on another, whether by cutting or bruising instruments, by his own person, or by forcing him against an obstacle, will have to be considered under this head. For the punishment of all such injuries when maliciously inflicted, the statute law makes provision, no less than for stabbing, cutting, shooting, drowning, strangling, and suffocating, by the insertion of the words "or shall by any means whatsoever wound or cause any grievous bodily harm to any person," and "by any means other than those specified," &c., and "with or without any weapon or instrument," &c. (§§ 11, 15, and 20, of 24 and 25 Vict. cap. c.)

In examining this large subject, the following arrangement will be adopted. The several kinds of mechanical injury will be separately considered, then the questions common to all such injuries; then the way in which they affect the more important organs of the body.

Three kinds of mechanical injury will have to be examined in turn:—Wounds as commonly understood, gunshot wounds, and mechanical injuries not usually designated as "wounds."

The old surgical definition of a *wound** makes it to consist in a *solution of continuity*. Mechanical injuries, therefore, may be conveniently divided into such as are *without solution of continuity*,

* "A wound is a solution of continuity in any part of the body suddenly made, by anything that cuts or tears, with a division of the skin." "By the word skin, I understand not only the external cutis, but also the inward membranes of the gullet, ventricle, guts, bladder, urethra, and womb, all of which are capable of wounds from sharp instruments, either swallowed or thrust into them."—Wiseman's 'Chirurgical Treatises,' book v. chap. i.

and such as are *with solution of continuity*. The first includes *contusions, concussions, simple fractures, dislocations*, and *sprains*, The second comprises *incisions, punctures*, and *lacerations, compound fractures*, and *gun-shot wounds*.

Each class of injuries, whatever the parts affected, has some points common to all the forms of violence included in the class. Thus, almost all injuries affecting the deeper-seated parts are accompanied by external traces of the force that produced them, whether it caused a solution of continuity or not. So that in most cases we shall have traces of the injury on the *surface*, and it will therefore be necessary to examine minutely the subject of bruises and incisions involving the external parts of the body.

The subject will be best examined under the following heads :— 1. The characters of contused wounds, and of injuries unaccompanied by solution of continuity. The characters of incised wounds, and of those accompanied by solution of continuity. 3. The characters of gun-shot wounds. 4. The questions common to all forms of mechanical injury. 5. Wounds as they affect the several important organs of the body. 6. The detection of blood-stains on clothes, weapons, &c.

I. CONTUSED WOUNDS, AND INJURIES UNACCOMPANIED BY SOLUTION OF CONTINUITY.

A blow with a blunt instrument causes an appearance on the surface commonly known as a bruise, in scientific language an *ecchymosis*. It consists in a discoloration of the skin produced by extravasation of blood into the cellular tissue. When this happens in the superficial parts, and especially in the lax and yielding skin, the colour shows itself at once; but when deeper-seated, days may elapse before the skin becomes discoloured, and then it is not blue, as in superficial parts, but of a violet, greenish, or yellowish hue: nor is it always immediately over the seat of injury, the point where the extravasation becomes visible being conditioned by the arrangement of the fascia and cellular tissue offering resistance in some directions but not in others.

The blue colour is not fully developed at once, but continues to deepen for five or six hours. When blood ceases to flow from the broken vessels, serum is effused, and inflammation is set up, and thus the bruise is enlarged. Its colour also undergoes a change, passing from deep blue to shades of green, yellow, and lemon colour. After a further interval, the effused fluids are absorbed, and the colours first fade and then wholly disappear. If the

injury has been severe, the inflammation runs on to suppuration, forming an abscess if deep, an ulcer if superficial.

The change of colour begins at the circumference, where the effused fluids are scanty, and travels inwards towards the centre, where they are abundant, and where the deep blue colour often remains after the rest of the bruise has completely changed its appearance. In bruises of any extent, and in parts that contain much blood, coagula are formed.

The extent of the bruise, and the rapidity of its changes, will depend on the force used, the size and character of the weapon, the age, constitution, and health of the sufferer, the full or empty state of the vessels, and the tension or laxity of the skin. A boxer in training would scarcely be marked by a blow that would disfigure a person in ordinary health; and in severe case of scurvy the lightest touch causes a bruise closely resembling that produced in healthy persons by greater violence.

As the form of a bruise is in part determined by the shape of the weapon, it often furnishes strong presumptive evidence. The subjects of death by hanging, strangulation, and suffocation have furnished good examples of this correspondence of bruises with their cause, and in one case (Starkie, 'Law of Evidence') a blow on the face given in self-defence with the key of the house door, caused a bruise which corresponded in shape to the wards of the key, and served to identify the man who had committed the assault.

The discolorations of a bruise are not confined to the cellular tissue, but involve the substance of the true skin. Bruises are thus distinguished from cadaveric lividity. (See p. 254.)

But even severe blows do not produce marks of injury on the surface when the parts beneath are soft and yielding. Thus blows on the abdomen which rupture the viscera do not always bruise the skin, though they sometimes cause the effusion of blood between the muscles. On the other hand, when severe injuries of hard parts, such as fractures of bone, are unattended by a bruise, there is a strong presumption against their having been caused by a blow.

Can the appearance of a Bruise be produced after Death?

This question is answered by Christison's experiments, from which it appears that, up to *two hours* after death, and in rare cases, three hours and a quarter, appearances may be produced more or less resembling bruises inflicted during life; blood is effused into the cellular tissue, on the surface of the cutis, and even into its substance; and the blood coagulates.

Distinction between Bruises inflicted during Life and after

Death.—In certain cases this distinction is easy. If there is much swelling, any change of colour, or any sign of inflammation, the bruise must have been inflicted during life.

If on incising the bruise, the effusion is found to be considerable and the clots large, there is a strong presumption that it was inflicted during life. So also if the cutis is discoloured by blood effused into its texture. This is a valuable diagnostic mark, except in the case of bruises inflicted a few minutes after death, when, judging from the analogy of incised wounds, we may expect the same appearances.

As the same effusion of blood, which, on the surface, constitutes a bruise, may, when it occurs in deeper-seated parts leave little or no trace upon the skin, it is important to ascertain whether such deeper effusions may take place after death as well as during life. This question has been answered in the affirmative. In the body of Margery Campbell, the victim of Burke (see p. 300), there were marks of severe injury to the back, to which Christison was at first inclined to attribute her death; and semi-fluid blood was found under the trapezius muscle, near the inferior angle of the scapula, and in the cervical, dorsal, and left lumbar regions, but there was no corresponding bruise on the skin. The posterior ligaments of the vertebræ were ruptured, but there was no fracture. On the sheath of the spinal cord, opposite the rupture, there was a mass of semi-fluid black blood an inch wide, and about the thickness of a penny, and a thin layer from this blood extended along the posterior surface of the sheath, as far as the lowest dorsal vertebra. The spinal cord was not injured, nor was there any blood under its sheath. Christison proved that all these marks of violence might be produced seventeen hours after death, by bending the head forcibly on the chest. In the body of Carlo Ferrari, also, five or six ounces of coagulated blood were found among the deep-seated muscles of the neck, from the occiput to the last cervical vertebra; and there was a large quantity of fluid blood in the upper and lower part of the spinal canal, exterior to the sheath of the cord, but no blood within the sheath; nor had the vertebræ, or their ligaments, or the cord itself, suffered any injury. The confession of the criminals showed that these injuries to the spine were produced after death.

The difficulty of determining whether a bruise was inflicted during life, or soon after death, is much increased if putrefaction has set in; for it exaggerates the appearance of injury, and produces great alterations of consistence and colour; while the pressure of the gases evolved may cause copious outpourings of blood, through ruptured vessels. This was well shown in the

body of a man who had died of apoplexy. The veins of both arms had been opened, but no blood had flowed during life. After death, however, an abundant hæmorrhage took place from the wounded vessels (G.).

In a case which occurred at Paris (p. 45), the effusion of blood caused by strangling was discovered as a black mass twenty years after death. But the cord was round the neck, and removed the difficulty which might otherwise have existed.

The same observations apply to *fractures*, and in nearly the same degree. A fracture produced soon after death, and one produced just before life is extinct, would probably present very nearly the same appearances; while a fracture caused some time before death, would be readily distinguished by the inflammation set up about it.

Fractures may be detected long after death—in the body of Clarke, the victim of Eugene Aram, the indented fracture of the temporal bone after the lapse of thirteen years.

II. INCISED WOUNDS, AND WOUNDS ACCOMPANIED BY A SOLUTION OF CONTINUITY.

Under this head are comprised incised, punctured, and lacerated wounds; gun-shot wounds being treated separately.

The immediate obvious consequences of wounds with solution of continuity are hæmorrhage, and retraction of their edges: the remote effects those of inflammation and its sequelæ. In a recent incised wound, inflicted during life, there is copious hæmorrhage, the cellular tissue is filled with blood, there are coagula between the lips of the wound, and the edges are everted. After from eighteen to twenty-four hours there are the signs of inflammation—increased redness, swelling and effusion of coagulable lymph.

As a rule, incised wounds, whether caused by cutting or slashing, are fusiform in shape, owing to the retraction of the tissues in the middle, and especially so when muscular fibres have been divided transversely. Incised wounds usually commence abruptly and terminate gradually, or tail off; sometimes, especially in cut-throat, the wound ends in two or more points, thus indicating the direction in which the instrument was drawn.

Incised wounds do not correspond in shape to the weapon which inflicted them, the wound being broader than the cutting edge.

A close resemblance to an incised wound may be caused by a blunt instrument, or by a fall, in firm resisting parts, as for instance on the integument covering the skull.

Copious hæmorrhage affords a strong presumption in favour of a wound having been inflicted during life, especially if the body is fresh. Scanty hæmorrhage, or the entire absence of it, as in the case of Sir Edmondbury Godfrey (p. 295), supplies an equally strong reason for attributing death to some other cause. But lacerated and severe gun-shot wounds form an exception to this rule. In the case recorded by Cheselden of a man's arm torn off by a windmill, and in one reported by Mr. Bransby Cooper, there was scarcely any hæmorrhage. On the other hand, very considerable hæmorrhage may take place after death, and especially when putrefaction is set up, if any large vein happens to be wounded.

In the case of incised, as of contused wounds, it is important to determine whether the appearances found in wounds inflicted during life may be produced after death.

Characters of Wounds produced after Death.—The experiments of Orfila on the dog have shown, that the appearances proper to incised wounds inflicted during life may be produced immediately after death; and the experiments of Dr. Taylor made on limbs recently amputated, show to what degree the resemblance may be carried.

When the incision was made two minutes after the removal, there was immediate considerable retraction of the skin, protrusion of the adipose substance, and scanty flow of blood; and, after twenty-four hours, the edges were found red, bloody, and everted; the skin somewhat flaccid; a small quantity of blood escaped on separating the edges; no coagula adhered to the muscles; but at the bottom of the wound were several loose coagula.

After an interval of ten minutes a second experiment was performed. The edges of the wound were slightly everted; scarcely any blood escaped; and twenty-four hours afterwards the edges were pale and perfectly collapsed, and at the bottom of the wound were found a few coagula.

When the wound was not made till *two or three hours* had elapsed, a small quantity of liquid blood was effused, and no clots were found. The edges of an incised wound made twenty-four hours after death were yielding, inelastic, in close approximation, and free from coagula.

Lacerated wounds combine the characters of incised and contused wounds, being attended with less hæmorrhage than the former, and less discoloration than the latter. The edges are generally torn, but, as above stated, though caused by blunt weapons or falls, they may be sharp and defined. They seldom correspond in shape with the cause. The distinction between

such wounds inflicted during life and after death is less easily made.

Punctured wounds are intermediate between incised and lacerated wounds, resembling the former when inflicted with a sharp instrument, and being often accompanied by profuse hæmorrhage; but when made with a blunt object, being more like lacerated wounds, and causing little loss of blood. The form depends on the shape of the weapon and the direction of the blow. They are generally smaller than the weapon. They resemble incised wounds if the weapon is a broad, two-edged blade. Wounds, when made by a perpendicular stroke, correspond to the breadth of the weapon, but a blow struck obliquely produces a longer wound. Weapons with a thick back and sharp edge cause wounds of a corresponding shape. Triangular weapons, such as bayonets, cause triangular wounds.

It must be remembered, however, that the same weapon may produce differently shaped wounds on different parts according to the tissue penetrated, and the amount of retraction which ensues.

Sword wounds traversing the body have a large depressed orifice of entrance, and a small raised orifice of exit; but this condition may be reversed when the weapon is drawn out, especially if it is rough from rust or otherwise.

The chief danger of punctured wounds is from injury to internal organs or penetration of internal closed cavities, such as the pleura.

III. GUN-SHOT WOUNDS.

These belong to the class of contused or lacerated wounds; of contused wounds when the shot does not penetrate, of lacerated wounds when it enters or traverses the body. They are, as Wiseman observes, "the most complicate sort of wounds"; they combine "contusion, attrition, and dilaceration" in a high degree; they occasion "all sorts of fractures"; they introduce extraneous bodies; and they give rise to hæmorrhage, inflammation, erysipelas, gangrene, and sphacelus. The lips of a gun-shot wound are "livid or blackish": they become the seat of inflammation and swelling; and "blisters frequently rise above them," containing "matter of a fœtid smell."

Gun-shot wounds caused by discharges close to the person are "burnt by the flame," and they may contain particles of unconsumed powder. If covered by clothes, these also may be blackened or burnt. As a general rule gun-shot wounds, unless they injure some large vessel, do not give rise to much hæmorrhage; but the destruction of parts from the sloughing and suppuration that

follow them, often occasions profuse and fatal discharges of blood.

The bullet, shot, or wadding discharged from fire-arms at short distances sometimes lodges in the body, sometimes traverses it. When it lodges, it often furnishes conclusive evidence. The bullet may have been cast in a mould, or the wadding formed by printed paper or other material, in the possession of the person who fired the shot. It may even happen that the composition of the bullet, or the mode of making it, is peculiar. In medico-legal cases, therefore, the contents of a gun-shot wound should be carefully examined, and preserved. When a bullet traverses the body, the two apertures should be carefully examined. The aperture of entrance is round and clean, and its edges are depressed, that of exit irregular and jagged. On entering the body "the bullet forces the flesh in with it, and the place by which it enters presently contracts closer; but its going out is more lax." The same difference of entrance and exit is seen in the clothes. Such is generally the case, but the rule is by no means absolute. Much depends on the velocity of the bullet and the amount of resistance it meets with in its passage through the tissues. The greater the loss of velocity the more the tearing, instead of clean penetration which attends great initial velocity. When conical bullets, with high velocity are used, the aperture of entrance is not readily distinguished from that of exit, for, as a general rule, the apertures differ little in size and have a somewhat triangular shape. This is so even when very extensive destruction of deep parts has been caused by the passage of the projectile. Bullets that strike the body obliquely produce a valvular wound.

Bullets which lodge in the body are often turned out of their direct course by contact with a bone, or other firm resisting structure. Thus (to give examples from the practice of Richard Wiseman) a bullet entered the cheek and was cut out from the back of the neck; a second, entered the outside of the small of the leg, and was found on the inside of the thigh above the knee; and a third entered the outside of the arm, and was cut out below the scapula. In some cases, the bullet has struck the head or abdomen, and after traversing the half-circumference of the part, has been found lodged, or to have passed out, at the opposite point. Again, bullets may be split into two or more fragments by striking a bone, and these fragments may either traverse the body or lodge in it. If they lodge, they may be found to have taken the same eccentric course as the undivided bullet in the cases just cited: if they traverse, they may occasion more than one wound of exit resembling that caused by a single bullet.

When a bullet takes a direct course through the body (that is to say, when it is not deflected) the character of the two apertures, coupled with the direction of the line which joins them, may serve to indicate the posture of the body when the wound was received. So also when after traversing a wooden paling, or a window, it strikes a wall beyond, the line of flight, and spot from which the shot was fired, may be determined.

Small shot discharged close to the body, and striking it at right angles, may cause a round clean wound not easily distinguished from one produced by a bullet; but at the distance of a foot or more the shot scatter, and the wound is irregular. At the distance of three feet the shot are so scattered that it is not possible to confound the injury with one caused by a bullet. In these wounds some of the shot lodge in the body, and when fired close, or within a short distance, there are marks of burning on the skin and clothing.

Fire-arms loaded with wadding, and fired close to the body, or within a few inches, may produce severe, and even fatal, penetrating wounds, and even at the distance of a foot may give rise to extensive superficial injuries. The unconsumed powder, when fire-arms loaded only with powder are discharged close to the body, may produce the same injuries as small shot.

From what has been said above of the complicated nature of gun-shot wounds, it is obvious that they are very dangerous. They may prove fatal, immediately or soon, by shock, or hæmorrhage, and, after a long interval, by secondary hæmorrhage, by erysipelas, by tetanus, or by the inflammation and extensive suppuration following the death of the injured parts.

The same medico-legal questions (such as the more or less dangerous character of the wound; the effect of the treatment adopted, and of the subsequent conduct of the wounded person, on the issue of the injury; and the amount of locomotion possible after it) arise in gun-shot as in other wounds.

The question whether the wound was the result of *accident*, *suicide*, or *homicide* may also be raised respecting these in common with other wounds. As a general rule, accidental wounds, whether inflicted by the wounded person, in loading, or in the act of carrying a loaded piece, or by another person pointing at him a piece supposed not to be loaded, or walking or shooting in his company, have the characters of wounds caused by discharges near the person; but these they share with suicidal wounds. But suicidal wounds have a character which accidental wounds often, and homicidal wounds sometimes, lack, of being inflicted in front on the head or region of the heart. To this rule, however, some

suicidal gun-shot wounds form an exception, the weapon being directed to the back of the head. As a general rule, too, the suicide fires only one shot; but suicides have been known to fire two pistols, and even to resort to fire-arms after the failure of incised wounds. In some cases the suicide is found in a room secured from within, with the weapon still grasped in the hand, and when the priming was of powder, with the hand stained by it.

Some information may be gained as to the time when the shot was fired, though the conclusions* can only be regarded as approximate. If the interior of the barrel blackens the finger introduced into it, and is free from crystals of protosulphate of iron, or rust, and the solution has a yellowish colour, smells strongly of sulphuretted hydrogen, and gives a black precipitate with acetate of lead, the weapon has not been discharged more than *two hours*. If the colour of the interior is less dark, but contains neither rust nor crystals of ferrous sulphate, but the solution gives traces of sulphuric acid—tested with acetate of lead or chloride of barium—the time that has elapsed is more than two hours, but *less than twenty-four* hours. When numerous spots of rust are visible in the interior, and when the solution gives indications of iron—tested by ferricyanide of potassium—*at least twenty-four hours, possibly six days* have elapsed. When the rust is more copious, and the solution no longer gives iron reactions, at *least ten days, possibly fifty days* have elapsed since the discharge.

IV. QUESTIONS COMMON TO ALL FORMS OF MECHANICAL INJURY.

There are three questions common to all forms of mechanical injury:—1. *Was it inflicted during life?* 2. *Was it the cause of death?* and 3. *Was it accidental, suicidal, or homicidal?* The first question has been already examined; the second and third remain to be discussed.

Was the Wound the Cause of Death?—The answer to this question presents no difficulty when a man in the enjoyment of perfect health receives a severe injury, and dies before sufficient time has elapsed for disease to set in, or neglect, or unskilful treatment to prove injurious. But when the interval is considerable between the receipt of the injury and the fatal event, such complications may arise, and make the answer to the question difficult.

But the abnormal formation or unusual situation of the part injured may entail a fatal result from an injury otherwise harmless. Of abnormal formation, the case of a boy caught robbing an

* Sonnenschein, 'Gerichtliche Chemie,' p. 379

orchard, whose death was caused by a blow intended as a simple chastisement, on a skull preternaturally thin, is a good illustration: of abnormal situation, that of an inguinal hernia injured by a kick, or the fatal hæmorrhage caused by a blow on the loins over the seat of a kidney containing a jagged calculus; or a large abscess behind the ear ruptured by the same means.

To this class of cases also belong those sudden deaths which follow falls or blows too slight to account for the fatal result by the direct injury they occasion, death being really caused by the rupture of a vessel on the brain, or of an aneurism; in both which cases it is possible to attribute death to the excitement of the struggle as well as to the fall or blow. Also those cases of latent effusion on the brain or into the cavities of the chest which might prove suddenly fatal even in the absence of violence, but are very likely to cause death under the influence of excitement or shock.

In these cases the injury is inflicted in ignorance of the existence of any cause by which, though comparatively slight, it might be rendered mortal. To all other cases, such as those of young, feeble, or aged persons, and pregnant women, the English law, as laid down by Lord Hale, will apply: "it is sufficient to prove that the death of the party was *accelerated* by the malicious act of the prisoner, although the former laboured under a *mortal* disease at the time of the accident."

The second class, or that in which an interval elapses before the wound proves mortal, comprises a greater number of special cases. Before treating of these in detail, it is necessary to premise that even when the interval between the injury and the fatal result is considerable, the death may be attributed to the injury without any misgiving; for it may be such that no strength of constitution, and no care or skill, could avert a fatal termination. In fractures or dislocations of the spine, for instance, and in gun-shot wounds when the bullet lodges in the body, however long the fatal result may be postponed, the death is fairly attributable to the injury alone. But though, in cases of this kind, no doubt can exist either respecting the true cause of death, or the guilt attaching to the act of violence, the lapse of time has, in most civilized countries, been taken into account, and by the common law of England, if the injured party survive one year and one day, the crime ceases to be murder; and English juries have sometimes shown a disposition to shorten this period very considerably.

Within this period of 366 days there is ample opportunity for some of the circumstances now to be specified to come into play.

1. A trifling wound or injury may prove fatal, from the injured part taking on an unhealthy character, such as scrofulous inflam-

mation due to peculiarity of constitution, or erysipelatous inflammation from exposure to contagion.

2. To the same class of cases belong attacks of fatal tetanus or of delirium tremens from slight injuries, as well as rare instances of pyæmia from latent abscess brought into activity by a fall or blow, and fatal diseases of internal organs arising independent of, but soon after, the injury.

3. Another circumstance bearing on the question, Was the wound the cause of death? is the improper management of the wounded party: whether consisting in the neglect of medical assistance, or of medical instructions; or in the resort to ignorant and unqualified practitioners; or in *mala praxis* on the part of a qualified medical attendant;* or in irregularities, and reckless exposure to cold, fatigue, or fresh injury, or to intoxication, on the part of the patient himself.

Was the Wound Accidental, Suicidal, or Homicidal?—Accidental death is a common occurrence in crowds, and in wrestlings and fights, when the deceased person falls, or is thrown, or struck against, hard resisting objects, in which case an examination of the spot will help to determine the question.

There is always a probability of accident when a body is found in a dangerous situation, as at the foot of a precipice, or in a river with steep banks; and the probability is increased when the deceased is proved to have been drinking. In all doubtful cases the character of the injuries will go far to determine the class to which the death belongs. Bruises, fractures, and dislocations, for instance, are more consistent with the theory of death by accident than incised, punctured, or lacerated wounds.

The alternative of accident being excluded by the nature of the case, the original question is narrowed to this, *Was the wound suicidal or homicidal?*

As suicide is much more common than homicide, there is always a *primâ-facie* probability in favour of suicide, especially in middle-aged persons; but this probability will be materially modified by such considerations as, the place in which the body is found; the nature, seat, extent, and direction of the wound; and the number of wounds.

* The following is the law relating to death from medical or surgical treatment with a view to cure, as defined by the Criminal Code Commission, sec. 173.—"Everyone who causes a bodily injury to any person from which death results, shall be deemed to kill that person, although the immediate cause of such death be treatment applied in good faith for the purpose of cure, even if such treatment was improper: Provided that if the injury was not in itself of a dangerous nature, and the improper treatment was the cause of the death, that shall be a defence to a charge of murder or manslaughter."

Place where the Body is found.– The finding of a corpse in a room with the windows and doors fastened on the inside, is conclusive of suicide. The absence of the instrument of death is conclusive as to murder. So also, if the blood from a mortal wound has been washed from the body or floor, or is found on the feet or person of one affecting innocence (see case at p. 241), or if the body itself has been placed in a position inconsistent with the mode of death, or covered, or buried.

Nature of the Wound.—*Contused wounds* are rarely suicidal, though attempts at self-destruction by knocking the head against the wall are not uncommon especially among the insane. Severe contusions, therefore, are most probably homicidal, unless the body is lying near a height from which it might have fallen, or from which the deceased might have thrown himself. *Incised wounds* are as likely to be suicidal as homicidal, and it is not easy to infer from the character of the wound to which class it belongs. The cleanness and evenness of an incised wound have, indeed, been thought to afford a probability in favour of homicide, but without sufficient reason; for a resolute suicide is more likely to have a steady hand than a murderer to meet with no resistance; and some of the deepest and cleanest wounds of the throat are certainly suicidal.

In a few instances the *shape* of an incised wound helps to determine the question of suicide or homicide, by indicating the sort of instrument used, and the occupation of the murderer. Thus, a man with his throat cut from within to without, as butchers slaughter sheep, was found to have been murdered by a butcher; and in the case of a body divided in two by a cutting instrument passed into the fibro-cartilage uniting the third and fourth lumbar vertebræ, so as to divide the articulating processes transversely, as butchers cut through the spines of animals, a butcher was proved to have been the murderer (Orfila).

Situation of the Wound.—If a wound is so situated that the instrument of death, when placed in the hand of the deceased, cannot be made to reach it, whether by the motion of the hand itself, or by that of the part injured, or by both jointly, it could not have been self-inflicted. Wounds on concealed parts, as within the labia, and beneath the breast of the female, are in all probility homicidal. It must, however, be borne in mind that while murderers sometimes inflict injuries of a kind to appear suicidal, many suicides are moved by very eccentric impulses.

Extent of the Wound.—It has been thought that a suicide would not have courage or strength to inflict a very severe wound on himself; but experience is opposed to this view. Suicidal wounds of the throat, for instance, are usually deep and extensive;

and nothing is more common than to read of the head being nearly severed from the body. But superficial wounds of the throat are among the most common forms of pretended suicide; and when two persons are found lying in the same room or place, the one severely wounded, perhaps dead; the other slightly, and alive, there is a strong presumption against the innocence of the survivor.

Direction of the Wound.—Suicidal wounds generally follow the natural movement of the arm from left to right, and from above to below. But in the case of left-handed persons, the direction would be reversed. Wounds of the throat, whether suicidal or homicidal, are, however, generally transverse. When persons of different statures fight, a wound inflicted by the taller man would pass from above downwards, and the reverse if given by the shorter, supposing both combatants to be standing. In wounds inflicted by a sword, or by fire-arms, their direction and the orifices of entrance and exit, should be noted.

Number of Wounds.—The coexistence of several mortal wounds affords a presumption against suicide, but only a presumption; for after inflicting on themselves wounds necessarily mortal, suicides have retained strength and determination to inflict others. Thus Orfila relates the case of a gentleman at Rouen found dead in his chamber, with two pistols lying, one near the body, the other on the bed, at some distance from it. He had shot himself in two places. One wound, apparently made while he was on the bed, had traversed the left side of the chest, breaking a rib before and behind, perforating the middle portion of the lung, and passing near the roots of the pulmonary veins. A large quantity of blood was extravasated in the chest. After inflicting on himself this serious injury, the deceased must have risen from the bed, walked to a closet to get another pistol, with which he produced a second wound that must have killed him instantly. The ball had entered the frontal bone, and, after traversing the left hemisphere of the brain, had lodged against the os occipitis. There was no doubt of this having been a deliberate suicide.

Watson gives a case of suicide in which no less than ten wounds were inflicted on the throat.

As most of the probabilities just established may lead to error if too implicitly relied upon, we have to be on our guard against false inferences from circumstances purely accidental as well as from arrangements made to deceive us.

Nor is it always safe to assume that a severe injury actually inflicted by another, is the real cause of death; for, as in a case related by Wildberg, a death occurring during a chastisement may, on examination, be found to have been due to poison.

The *circumstantial evidence* in death by wounds is of great

importance. *See* "persons found dead" (p. 239). Sellis, a servant of the Duke of Cumberland, afterwards King of Hanover, was found dead on his bed with his throat cut, while his master, severely wounded in the head and hand, was under the care of Sir Everard Home. The Duke stated that he was roused from sleep by a blow on the head, followed by several others, one of which caused an immense effusion of blood; that he leaped out of bed, and followed his assailant, who repeatedly struck at him, and would doubtless have murdered him, but that the doors protected his person from some of the blows. Every part of this statement was confirmed by the circumstantial evidence. The coloured drapery at the head of the Duke's bed was sprinkled with blood; there were traces of blood on the passages and staircase, and on the doors of all the State apartments; and Sellis's coat was found on a chair out of reach of blood from his bed, but with the sleeve sprinkled from shoulder to wrist "with blood, quite dry, and evidently from a wounded artery."

Lord William Russell, the victim of Courvoisier, was found dead in bed with his throat cut; the instrument of death did not lie near the body, and a napkin was placed over the face. A woman of the name of Norkott was found dead in bed with her throat cut, and on her *left hand* a bloody mark of a *left hand*. In both these cases the evidence of murder was complete.

There are still other questions to be considered, as for instance whether a given wound is dangerous to life, and, of many wounds, which was mortal. It may also be important to know how long the wounded person survived the injury, and to fix the point of time at which a wound was inflicted.

Is the Wound Dangerous to Life?—It is easy to answer this question in the case of injuries to large blood-vessels and important viscera, less easy in the case of injuries which affect life rather by their extent than the importance of the parts implicated; for while, on the one hand, slight injuries to unimportant parts may, in peculiar states of constitution, prove fatal, on the other, men may recover from injuries the most severe and extensive, as in the well-known case of Mr. Tipper, pinned against a stable-door by the shaft of a gig traversing the chest.

The danger attending injuries of the several important parts of the body will be found discussed under the next heading.

Of many Wounds, which was Mortal?—It is easy to understand how this question may become important. A mortal struggle may begin with blows and end with the use of a stabbing or cutting instrument; and the crime would have a very different aspect, according as the death was attributable to the blows or to the stabs

or cuts. The question is of so general a nature that it must suffice to indicate its importance.

How long did the Wounded Person Survive?—This question, too, may evidently assume importance, especially in connexion with the amount of exertion possible after severe injuries. It involves many details, and must be reserved for the next division.

When was the Wound inflicted?—This question may arise either during life or after death. During life the question must be answered, in the case of contused wounds, by the extent of the ecchymosis and the colour it assumes; in the cases of incised and punctured wounds, by the state of the divided parts, whether they are filled with extravasated blood or not; and whether the edges are swollen, and the surrounding skin inflamed. After death the question either resolves itself into the simple inquiry, How long has the deceased been dead? or into the double question of the date of the death and the length of time that the deceased survived. The presence or absence of animal heat, of cadaveric rigidity, and of putrefaction, and the progress which putrefaction may have made, must be taken into account. These changes take place, as already observed (p. 248), with very different degrees of rapidity in different subjects; so as to oblige us to speak of the time they occupy with caution and reserve.

V. WOUNDS AS THEY AFFECT THE SEVERAL PARTS OF THE BODY.

Some of the questions which have been indicated as important in the previous division, will be examined in detail in this.

Wounds of the Head.—Injuries to the *scalp* are more important than those of the integuments of other parts, on account of the peculiar tendency of the skin itself to take on the erysipelatous inflammation; the quantity of loose areolar tissue intervening between the tendon of the occipito-frontalis and the periosteum, which is very liable to become the seat of diffuse inflammation, and the relation of the tendon to this lax tissue, preventing, as it does, the escape of effused products. Punctured and contused wounds of the scalp are dangerous on account of the inflammation they set up in this tissue, and the want of free exit for the discharges. But extensive lacerated wounds which do not involve the periosteum are rarely serious, inasmuch as they afford free passage to the products of inflammation.

Fractures of the Skull are not of themselves more important than those of other bones, but for the fact that the injury that occasions the fracture also produces concussion, or other injury to the brain, or its membranes. A blow on the skull, it should be

observed, does not always fracture the bone on which it alights, but may produce a counter fracture at an opposite part of the skull. A severe blow or fall on the vertex of the head, for instance, will often occasion a fracture at the base.

The danger attending injuries to the skull varies with the thickness of the part struck. A blow on the temple would produce greater injury than one of equal force applied to other parts; the thinness of the orbitar plate and of the cribriform plate of the ethmoid bone, exposes the brain to serious injury from thrusts with pointed instruments.

Injuries of the Brain may be classified under the heads of *concussion* or commotion, *contusion, compression, wounds, effusion, inflammation* and its consequences (encephalitis and meningo-encephalitis).

Concussion, or commotion, is a term applied to the assemblage of symptoms resulting from a violent jar to the nerve centres, such as may be caused by a direct blow on the head or communicated to it through the spine—as by a fall on the buttocks.

The symptoms occur immediately on receipt of the blow, and vary in intensity and duration. Consciousness is lost, there is complete muscular relaxation, the face is pale, the pupils dilated, and respond to light imperfectly if at all, the pulse is feeble, and the respiration superficial or irregular. Nausea and vomiting usually occur as the patient begins to recover. In some cases these symptoms are transient—a momentary stun—but in others they last some hours, or death may take place without reaction; or the patient may recover from the concussion, die from effusion with compression, or from inflammation and its consequences.

The exact pathology of concussion has been much discussed, but it is possible for fatal concussions to occur without any other marked appearances beyond general venous congestion.

The injury, however, which causes concussion, not unfrequently also causes *contusion* of the brain. This is characterized by the appearance at the seat of injury, or on the opposite side, or at the base of the brain of scattered punctiform hæmorrhages, situated superficially, or, it may be, in the substance of the brain.*

In such cases, in addition to the symptoms characteristic of concussion, we may have superadded symptoms indicative of localized lesions in the form of paralysis or convulsions.

Contusion is very apt to be followed by hæmorrhagic effusion of considerable amount, leading to compression; or by inflammation.

* See Duret, 'Sur les Traumatismes Cérébraux;' Thèse, 1878.

Compression of the brain may result from depressed fracture of the skull, and the symptoms may remain for a long period, and be immediately relieved by elevation of the depressed bone.

Compression may also result from effusion of blood on the surface or in the substance of the brain, or from the products of inflammation set up by a cranial injury.

Compression is a common sequence of concussion with contusion and it is not always easy to determine whether we have to deal with concussion merely or with concussion and compression.

Very often, however, the individual recovers from concussion, and after an hour or two begins to complain of pain in the head, noises in the ears, giddiness, sickness, confusion of ideas, and weariness, gradually passing into stupor and coma, with complete loss of consciousness, dilated pupils, stertorous breathing and slow pulse. Convulsions also may occur.

These symptoms are due to the more copious effusion of blood from the ruptured vessels during the reaction which takes place after the first shock of the concussion; but if the symptoms of compression do not come on for several days after the concussion, we cannot attribute them to hæmorrhage.

Rapid and fatal hæmorrhage is specially apt to occur from fracture of the anterior inferior angle of the parietal bone and rupture of the middle meningeal artery, and consequent effusion between the dura mater and the skull. Or the effusion is on the surface of the brain from rupture of the vessels of the pia mater. But effusion of blood from cranial injury may also take place in the interior.

In compression due to depressed bone the cause of death is obvious; but when it arises from effusion following injury, it may be alleged that the effusion and consequent fatal results were due, not to the injury itself, but to some concomitant circumstance. Thus, if in the course of a struggle a man is thrown down or struck, and dies soon after with symptoms of compression, and an effusion of blood has taken place, this may be attributed to the excitement of the contest, and not to the injury itself; and this is the more likely to be the case if the deceased was given to habits of intoxication, or was by age or disease predisposed to apoplexy.

In such cases careful search must be made for indications of disease of the blood vessels such as atheroma or miliary aneurisms, disease of the kidneys, hypertrophy of the heart, in all of which conditions cerebral hæmorrhage is specially apt to occur. Should none of these conditions be met with, if the individual is young, and the effusion is from the middle meningeal or on the

surface of the brain, death is to be attributed to the cranial injury. If the signs of disease co-exist with those of the cranial injury, probably both factors may have been at work, and there will be room for difference of opinion.

Wounds of the brain are very variable in their effects. While fatal effusion or inflammation may result from comparatively slight wounds, on the other hand recovery may take place from the most extensive laceration and loss of substance, and with comparatively little effect on the mental or bodily powers.

Many such cases are recorded in the works of Paré, Wiseman, and modern surgical writers. A well-known case is the American crow-bar case, in which recovery took place after the passage of an iron bar through the left side of the frontal lobe.* Wounds may be made in the frontal, occipital, or temporo-sphenoidal lobes without producing paralytic symptoms, but if the convolutions bounding the fissure of Rolando are affected, general or partial paralysis of the opposite side ensues according to the extent and position of the lesion.† Aphasia has resulted from traumatic lesions of the left hemisphere in the region known as Broca's convolution. When a bullet or other missile lodges in the brain, an interval of several days may elapse before symptoms of inflammation show themselves; the patient meanwhile lying free from suffering, but showing by some such symptom as aphasia that the function of some part of the brain has been destroyed.

Inflammation.—Inflammation of the brain (encephalitis) and its membranes (meningitis) is a very common result of injuries of the head, whether the skull be fractured or not—most frequently in the former case. It is also a very insidious sequela, often showing itself many days or even weeks after the receipt of the injury. Most commonly after a week or ten days the symptoms make their appearance, during which interval the patient may apparently have quite recovered. The result may be diffuse inflammation and suppuration, or a large cerebral abscess may form, leading to death with all the symptoms of compression. A very instructive case of cerebral abscess resulting from a blow on the head without fracture of the skull has been recently put on record by Dr. Burney Yeo.‡ No distinct symptoms pointing to cerebral lesion showed themselves for more than six weeks after receipt of the injury, and death did not ensue for three weeks after they were fairly developed.

* See Ferrier, 'The Localisation of Cerebral Disease,' 1878.

† On this, see Ferrier, op. cit.

‡ 'Brit. Med. Journ.,' June 7 and 14, 1879.

Injuries of the head, therefore, have this peculiarity, that at first they often seem of little consequence, but after an interval, often considerable, dangerous symptoms arise and end fatally. During this interval a patient may be neglected or mismanaged, or may so misconduct himself as materially to affect the question—was the injury the cause of death? Such injuries, even if they do not prove fatal, not unfrequently cause epilepsy, paralysis, or even insanity, at a more or less distant date.

Injuries of the Spinal Cord.—The spinal cord is liable to the same affections as the brain, and from similar causes. The two are often affected together by the same injury. We may have concussion or commotion from violent blows on the back, or jars; compression from the effusion of blood, or by dislocated or fractured vertebræ; wounds; and local or general meningitis and myelitis.

The effect of lesions of the spinal cord varies with their seat. Injuries of the medulla oblongata and upper part of the spinal cord, such as occur from dislocation of the neck or fracture of the cervical vertebræ, are instantly fatal by affecting the centres of circulation and respiration. In general if the injury is below the origin of the phrenic nerve, but above the origin of the brachial plexus, paralysis of all the limbs and trunk ensues—an injury which may be fatal in a few hours, or after the lapse of many weeks, or months, or even years. In the case of John Carter, of Coggeshall in Essex, displacement of the last three cervical vertebræ with pressure on the cord opposite the seventh vertebra, did not prove fatal for fourteen years.

When the cord is injured in the dorsal or lumbar region there is paralysis or impairment of motion and sensation below the seat of injury, with loss of control over the sphincters.

Such injuries would be speedily fatal but for constant attention and nursing, but with these aids life may be prolonged for many years.

Of great importance in a medico-legal point of view are the effects of spinal concussions, more particularly in connection with railway accidents, a fertile source of litigation.*

In some cases death results from general spinal concussion. In others, a temporary paraplegia with pains in the limbs ensues, from which the individual may entirely recover in the course of a day or two. On the other hand the recovery may only be partial and the patient suffers from weakness, pains, and abnormal sensations in the limbs, with wasting of the muscles, and tender-

* On this subject, see Erichsen 'On Concussion of the Spine,' 1875. Erb on Diseases of Spinal Cord, Ziemssen's 'Cyclopædia.'

ness on percussion of the spine for a long period subsequently, though he may eventually recover.

In other cases the symptoms do not show themselves immediately on receipt of the injury, but make their appearance often weeks or months afterwards, and are attributed to slowly progressive degeneration in the cord and membranes.

The patient becomes exceedingly emotional and hysterical, irritable and sleepless, and incapable of mental exertion. Sight becomes impaired. The limbs are weak and the gait unsteady or ataxic. The back is stiff and painful on movement or percussion. Numbness and perverted sensations are complained of in the limbs; but there is seldom complete paralysis either of motion or sensation. The nutrition of the muscles also suffers, and they often lose their contractility. The bladder is weak and the sexual powers are greatly impaired or lost. There is general impairment of nutrition, coldness of the extremities and other signs of general prostration.

This assemblage of symptoms is said to be characteristic of "railway spine," but as many of them are of a purely subjective character, and the individuals often wilfully simulate or exaggerate symptoms, the utmost caution is necessary, and special knowledge of nervous diseases is required, in order correctly to appreciate the real amount of injury sustained. So long, however, as the present system of examining injuries and awarding damages prevails, we may continue to expect the not very edifying conflicts of opinion among medical witnesses in courts of law.

Wounds of the Face.—These not only occasion disfigurement but, in consequence of the free distribution of important nerves still more grave inconvenience. From the near proximity of the principal features to the brain, there is also a risk of injury to that organ, as well as of inflammation extending from the seat of the wound.

Wounds of the Throat.—These are the cause of death in a great majority of suicides, and sometimes a murderer inflicts a wound on the same part, hoping that his victim will be supposed to have committed suicide. The degree of danger depends on the parts implicated; wounds of the anterior part of the throat being less dangerous than those of the side of the neck; those of the lower part less so than those of the upper. A division of the carotid artery is almost necessarily fatal, and that of the internal jugular vein attended with great danger from hæmorrhage, from the introduction of air into the circulation, and from phlebitis. Wounds of the larynx or trachea are attended with comparatively

little danger, those of the trachea being less important than those of the larynx.

The question, Was the wound the cause of death? is easily answered, but the question, Was the wound suicidal or homicidal? not so readily. There is also a question of considerable interest relating to these wounds—namely, What amount of voluntary motion is possible after the receipt of a severe wound?

These questions of suicide or homicide, and of the amount of voluntary motion possible after a severe wound in the throat, were raised in the case of Captain Wright, who shared the captivity of Sir Sydney Smith and his celebrated escape from the Temple, and who had the misfortune to be taken a second time and imprisoned in the same place. He was found dead in his bed with his throat cut, and the razor closed in his right hand. There was an extensive transverse wound on the anterior and superior parts of the throat, above the bone of the windpipe, cutting through the skin, the muscles, the windpipe, the gullet, and the blood-vessels, and penetrating to the cervical vertebræ. The circumstances of the case are involved in so much mystery that it is impossible to determine by the evidence collected with great pains by Sir Sydney Smith, whether Wright really committed suicide or not. But that the mere fact of the razor being found closed in his hand does not militate very strongly against the supposition of suicide, is shown by the cases that follow. In September, 1838, an officer in the army was found dead, with the head nearly severed from the body, and there was no doubt that the act was suicidal; yet the razor had been put on the dressing-table. A madman, after inflicting a severe wound on his throat had time to struggle with the maid-servant before he fell down dead. In October, 1833, a man cut his throat with a razor while walking along Oxford Street, dividing the carotid artery and several of its branches, the jugular vein on one side, and the trachea; yet he was seen to hold a handkerchief to his neck, and run four yards before he fell dead on the pavement. He held the razor firmly grasped in his hand.

In the remarkable case of Mary Green, murdered in 1832, by John Danks, the confession of the culprit, and the circumstantial evidence coincided to prove that, after a wound which divided *the trunk of the carotid artery, and all the principal branches of the external carotid, with the jugulars*, she must have risen from the ground, run a distance of *twenty-three yards* and climbed over a low gate. It took from fifteen to twenty seconds to run from the spot on which the murder was committed to that on which the body was found.

Wounds of the Chest.—Incised wounds of the walls of the chest

are not dangerous; but severe blows often prove fatal by the shock they occasion, or by fracturing the bones, and causing rupture of the viscera, leading to hæmorrhage or inflammation. Such injuries occur in prize-fights, in falls from great heights, and from heavy objects crushing the chest. Penetrating wounds of the chest can scarcely fail to injure some important organ, occasioning thereby fatal hæmorrhage or severe subsequent inflammation; but cases are recorded of sword and gun-shot wounds traversing the chest without causing any bad symptoms; and most of the cases of injury to the chest that were under Wiseman's care after the battl of Dunbar seem to have recovered.

Wounds of the Lungs.—Hæmorrhage is the immediate conse quence of these injuries. The blood may be discharged by th wound, or by expectoration, or it may accumulate in the cavity o the pleura, causing great difficulty of breathing. When the larg vessels are wounded, the hæmorrhage is copious and speedily fatal Injuries to the substance of the lung itself are not necessaril fatal, for patients have recovered after removal of a portion of th lung, and, in rare instances, foreign bodies, such as bullets, hav remained in the lung for years, enclosed in cysts. Inflammatio is a common consequence of these wounds, especially when foreig substances are introduced, as happens in injuries with fire-arm Cases of wounds of the lungs require careful management, an long-continued rest. Emphysema is a familiar effect of thes wounds; but when judiciously treated does not materially increas the danger.

Wounds of the Heart.—Penetrating wounds of the heart ar speedily fatal from hæmorrhage, unless they pass so obliquel through the walls that the flap acts like a valve, or a foreig body happen to plug the orifice, when death may be delaye for some hours or even days. Wounds of the base prov more speedily fatal than those of the apex, and superficial wounc that divide the nutrient vessels less promptly than such a penetrate its cavities. John Bell gives the case of a soldier, i whom the apex of the heart was cut with the point of a lon and slender sword; and yet this man lived twelve hours, durin which time the heart had, at every stroke, been losing a sma quantity of blood, till it entirely filled the chest, and suffocate him. Another man was wounded with a sword, the point which cut the coronary artery; but it was two hours before th pericardium filled with blood, and then, after great anxiety, th patient died.* In very rare instances, when the wound does n prove fatal by hæmorrhage, complete recovery takes place

* 'Principles of Surgery,' vol. i. p. 468

in a case related by Fournier, and authenticated by M. Mansen, chief surgeon to the hospital at Orleans, of a patient who died six years after receiving a gun-shot wound, from disease unconnected with it, when the ball was found embedded in the heart. MM. Ollivier and Sanson have collected a number of cases of penetrating wounds of the heart, with a view of determining the probable period at which they prove fatal. Out of twenty-nine cases of wounds of the cavities only two were fatal within forty-eight hours. In the remainder, death took place in periods varying from four to twenty-eight days.*

Wounds of the Aorta and Pulmonary Artery are necessarily fatal; but patients have lived a few days after small punctured wounds even of the aorta.

Wounds of the Œsophagus and Thoracic Duct.—Such injuries are necessarily rare from the great depth at which these parts lie. They are dangerous from the extravasation of their contents. Orfila records a recovery from a bayonet-wound of the œsophagus.

Wounds of the Diaphragm.—Punctured wounds of this part do not appear to be attended with great danger, unless they involve injury to the parts above or below. Fatal hernia of the stomach is an occasional result. Death may take place after a long interval from the protrusion of the viscera of the abdomen into the chest, and consequent functional disturbance. Rupture of the diaphragm from severe blows or falls is in most cases attended by nervous shock and sudden death.

Wounds of the Abdomen.—Incised wounds of the abdominal walls may prove fatal by dividing the epigastric artery. In wounds of the tendons, as in scalp wounds, danger may arise from the accumulation of matter. Ventral hernia is a remote consequence of wounds of the abdominal walls. Severe blows may prove fatal by shock, hæmorrhage from ruptured viscera, or inflammation. The liver and spleen are the organs most liable to rupture.

Wounds of the Liver.—Deep penetrating wounds of this organ usually prove fatal by dividing the large vessels, but sometimes by giving rise to inflammation; and wounds of the gall-bladder by causing effusion of bile, and consequent peritonæal inflammation.

Wounds of the Spleen.—Deep wounds are fatal by hæmorrhage; but superficial wounds are not always mortal. Rupture of the spleen by blows is fatal, according to the amount of injury, in from a few hours to several days. In a convalescent patient, a kick over an enlarged and extremely soft spleen caused

* 'Dict. des Sciences Médicales,' art. *Cas rares.*

the effusion of several ounces of blood, and death in a few minutes.*

Wounds of the Stomach.—These kill by shock; by hæmorrhage from the large vessels; by extravasation of the contents and consequent peritonæal inflammation; and by inflammation of the viscus itself. But they are not always fatal, and many cases of recovery are recorded, even when the wound was extensive, and the stomach distended with food.

Wounds of the Intestines.—These prove fatal like those of the stomach by hæmorrhage, by discharge of contents, and consequent peritonitis, or by inflammation. The danger is great in the small intestines, and greatest in the duodenum, from the fluid state of their contents, and greater risk of extravasation. Wounds of the intestines sometimes heal by the effusion and organization of coagulable lymph.

Wounds of the Kidneys.—Penetrating wounds of the kidneys may cause fatal hæmorrhage, extravasation of urine, or inflammation. If the urine can be prevented from flowing into the peritonæal cavity, recovery may take place.

Wounds of the Bladder, especially when the organ is distended, prove fatal by extravasation of urine and consequent inflammation. After rupture of the bladder, the sufferer may walk some distance; but the accident proves ultimately, though not speedily, fatal.

Wounds of the Genital Organs.—A removal of the penis, if not fatal by hæmorrhage, is not dangerous; but an incised wound of the urethra entails the risk of extravasation of urine and fatal sloughing. The removal of the testicles is attended with less danger than a contusion, which sometimes proves fatal by shock. Wounds of the spermatic cord occasion dangerous hæmorrhage. The complete removal of all the parts of generation of the male may lead to no bad result. Deep wounds of the labia of the female are dangerous from hæmorrhage. Fatal injuries have been inflicted on the uterus, bladder, or rectum, or on the large vessels of the pelvis, by instruments introduced into the vagina.

Consult Watson's 'Medico-legal Treatise on Homicide.'

VI. DETECTION OF SPOTS OF BLOOD.

The medical jurist may have to examine red spots supposed to be caused by blood on wearing apparel, on cutting instruments, on floors or furniture, or wherever they may have fallen; also, in some cases, to examine watery solutions of blood; and he may

* Robert Williams 'Elements of Medicine.' vol. ii. p. 470.

be asked to assign the source whence the blood, if human, had flowed, and to distinguish it from that of animals.

When the blood-spot is recent, and the quantity large, it presents highly characteristic appearances, and yields a solution of a peculiar colour, readily distinguished from all other red fluids by its chemical, microscopical, and spectroscopical properties. But when the spots are not recent, and the quantity of the blood is small, great care is needed in the work of identification.

We will first describe these tests, and then show their application to the detection of stains.

1. *Chemical tests.*—The colouring matter of the blood is completely soluble in cold water, and yields a red solution, which is *coagulated by heat*, and changed to a dirty slate colour. The addition of *liquor potassæ* dissolves the clot, and yields a solution, dark green by transmitted, and red by reflected light. The coagulum reappears on the addition of nitric acid. The blood solution has also the characteristic property of not being changed in colour by the addition of a small quantity of *liquor ammoniæ*. No other red solutions have these two characters. The red, pink, or scarlet infusions of flowers and roots, and the juices of fruits, are changed to green or violet by ammonia, and cochineal to crimson. The red solution of the sulphocyanide of iron yields with the same reagent a precipitate of oxide of iron, and the pink solution of permanganate of potash is changed to blue. Chlorine water turns the blood solution at first slightly green, then discolours it, and produces, especially on warming, a flocculent white precipitate.

Blood solutions yield a red precipitate to *infusion of tannin* or *tincture of galls;* but red colouring matters, due to salts of iron, a dark blue precipitate. *Acetate of zinc* in presence of ammonia throws down a flocculent reddish precipitate (Gunning).

A solution of *tungstate of sodium,* acidulated with acetic or phosphoric acid, gives a red precipitate, soluble in ammonia, forming a dichroic, greenish-red fluid, again precipitated by acids. The precipitate, when fused with soda and a little nitre, leaves an insoluble residue of oxide of iron (Sonnenschein).

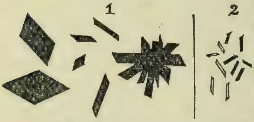
Ozonic, or Guaiacum, Test.—The blood-solution possesses the property of transferring ozone from substances that contain it (peroxide of hydrogen, ozonic ether, or oil of turpentine) to ozone reagents, such as tincture of guaiacum, which are oxidized and change colour. If to a solution of the colouring matter of the blood a few drops of tincture of guaiacum* are added, and then

* Made from the interior of a piece of the resin, and diluted to a brownish yellow tint.

a few drops of solution of peroxide of hydrogen, a rich, sapphire-blue colour results. This test is directly applicable to stains on linen, which, when moistened with tincture of guaiacum, and then with peroxide of hydrogen solution, assume a blue colour. This test, though very delicate, is not quite conclusive, as certain other substances give a similar reaction with guaiacum.

Hæmin Test.—Of all the tests for the colouring matter of blood this is the most certain. But as there are certain conditions in which it fails, such failure must not be taken to prove the absence of blood. If the test succeeds, it is conclusive of its presence. To apply this test, we use the blood solution evaporated to dryness, or a small portion of dried blood from a stain, or the precipitate caused by tannin, or acetate of zinc. The dried residue of the solution in a watch-glass, or a portion of dried blood on a microscope slide, is covered with glacial acetic acid, a crystal of chloride of sodium added, and then carefully heated to boiling over a spirit-lamp. It is well to add the acid more than once, especially if a slide is used. On allowing the mass to cool, the microscope reveals mixed with crystals of chloride and acetate of sodium, immense numbers of dark-brown rhombic prisms of hæmin, as in fig. 36, after Virchow, in which (1) shows large crystals, and (2) small crystals from a minute recent spot of sheep's blood. They vary much in size according to the rate of crystallization.

Fig. 36.



× 300 Diameters. × 150.

These crystals are a compound of hydrochloric acid with hæmatin, which is one of the products of the decomposition of hæmaglobin. They are known as *Teichman's Crystals.*

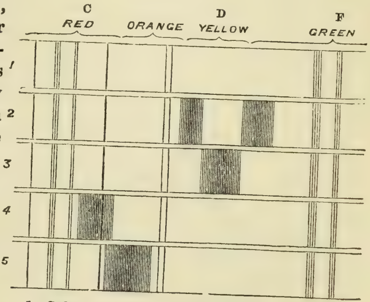
If the stain has been dissolved in a solution of common salt (1 in 200), it is not necessary to add the chloride of sodium.

Spectroscopic Test.—Solutions of the colouring matter of the blood, examined by the spectroscope, give a spectrum characterized by the presence of definite absorption bands. If the solution is too concentrated, only the red end of the spectrum is visible. When of the right degree of concentration, two dark absorption bands are seen in the green between the lines D and E. The first absorption band (*i.e.* from the left) is narrower and more sharply defined than the second, which is separated from it by a green interspace. In very dilute solutions the second is the first to disappear. The spectrum, with the two absorption bands, is that of oxidized hæmaglobin (2, fig. 37). When a reducing

agent is added to the solution, such as ammonium or sodium sulphide, or a solution of ferrous sulphate acidified with tartaric acid to prevent precipitation by alkalies, the two bands disappear; and in their stead one only is seen, dark in the middle, and with washed-out edges, occupying what was the green interspace between the two bands of oxidized hæmaglobin. This is the spectrum of reduced hæmaglobin (3, fig. 37). By shaking the solution with air it is again reoxidized, and gives the spectrum with the two lines as before.

A red solution possessed of the above characters can only be a solution of blood colouring matter. Other red solutions, such as carmine and alkanet, give spectra which, on careless inspection, might be mistaken for solutions of hæmaglobin; but their bands do not occupy exactly the same position in the spectrum, nor are they capable of reduction and reoxidation in the manner described. The reduction test should, therefore, always be had recourse to in determining by the spectroscope whether a given solution is a blood solution or not. Hæmaglobin, on the other hand, is liable to undergo decomposition spontaneously and under the influence of various reagents, and the spectrum undergoes corresponding alterations. By long exposure to the air, or under the influence of acids and alkalies, hæmaglobin is decomposed into a brown colouring matter *hæmatin* and a proteid substance. The colouring matter is no longer soluble in water, but is more or less soluble in dilute alkalies. If acetic acid is added to a solution of hæmaglobin, the solution becomes brown from the formation of hæmatin. If the turbid fluid is shaken with ether, a clear ethereal solution will be obtained, which, when examined with the spectroscope, shows a characteristic absorption band coinciding nearly with Frauenhofer's line C in the confines of the red and orange (4, fig. 37). Similarly alkalies split up hæmaglobin

Fig. 37.

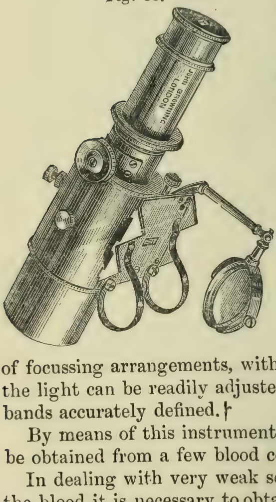


1. Solar spectrum. 2. Oxidized hæmaglobin. 3. Reduced hæmaglobin. 4. Hæmaglobin decomposed by acids. 5. Hæmaglobin decomposed by alkalies.

into hæmatin and a proteid substance. In this case the hæmatin band is broader, and is situated lower down the spectrum nearer the line D, while the blue end of the spectrum is much obscured (5, fig. 37). This alkaline hæmatin possesses the property of being reducible like hæmaglobin and again oxidizable. The spectrum of reduced hæmatin is characterized by two well defined absorption bands, similar to those of oxy-hæmaglobin, but situated lower down nearer the blue. In blood colouring matter which has been exposed to the atmosphere for some time, but which has not been entirely changed into hæmatin, a spectrum is obtained which gives three bands, one almost identical with the hæmatin band, and the other two like those of oxy-hæmaglobin. This is supposed to indicate an intermediate transformation of the hæmaglobin into methhæmaglobin.*

In applying the spectroscopic test for blood, the ordinary spectroscope may be used if the quantity is comparatively large. The colouring power of hæmaglobin is very intense, 1 in 4500 of water giving the absorption bands in the ordinary spectroscope. If the quantity is very small—such as may be got from a small stain—the micro-spectroscope of Messrs. Sorby and Browning affords a very delicate method of manipulation. (Fig. 38.) It consists of an instrument which can be substituted for the eye-piece of the microscope; and contains the requisite prismatic arrangements for placing side by side a spectrum of the object on the stage, and (by the side slit) a second beam of light from any object whose spectrum it is desired to compare with that of the object on the stage. By means of focussing arrangements, with which the apparatus is supplied, the light can be readily adjusted, and the spectra and absorption bands accurately defined.†

Fig. 38.



By means of this instrument the spectrum of hæmaglobin may be obtained from a few blood corpuscles.

In dealing with very weak solutions of the colouring matter of the blood it is necessary to obtain a certain depth of colour before

* Consult Preyer, 'Die Blutcrystalle,' 1871.

† Sorby, 'Proc. Roy. Soc.,' vol. xv. and various other memoirs.

the absorption bands become visible. For this purpose the cells invented by Mr. Sorby are admirably adapted. One form consists of a piece of barometer tubing about an inch in length, which is soldered on to a glass slide. By proper focussing and arrangement of the diaphragm, the light is made to traverse the whole column of the fluid, and thus with a very slightly coloured solution a sufficient degree of concentration is obtained. The other form is a wedge-shaped microscopical cell. When closed with a covering of glass a wedge-shaped body of fluid is obtained, and the thick or thin edge placed in front of the objective as required. These cells also allow of the addition of reducing agents to the solution, so that all the spectroscopic reactions can be studied with excessively small quantities. The spectroscopic test for blood colouring matter exceeds in delicacy all others.

Microscopical characters.—Blood is recognised under the microscope by the presence of the red (and white) corpuscles. The red corpuscles are highly characteristic. Their microscopic characters require to be well studied, inasmuch as circular forms are very commonly met with, as in the oil-globules of milk, the spores of yeast, and many crystalloids, organic and inorganic. The appearance of the globules in mammalia is shown in plan and section, largely magnified, in the annexed figure, after Gulliver. They have also been depicted in plan as a circular disk with shaded centre; in section as a biconcave lens. But their appearance differs with the power of the microscope, the light, and the focus. When viewed by transmitted light, they appear, when out of focus, as convex disks with faint outline; as we approach the true focus, the outline becomes dark and distinct; and when quite in focus, they seem to have a dark inner margin, a slight shaded depression, or a dark central shadow. Similar changes take place when the mirror is slowly moved, so as to place the object under a succession of brighter and dimmer lights. The observer should provide himself with a standard specimen of human blood globules with which to compare, for form and size, that which happens to be under investigation. The figure annexed shows the blood corpuscles as isolated disks (*a*) in plan; (*b*) in profile; (*c*) aggregated like piles of coin; (*d*) variously contracted and crimped by the exudation of their

Fig. 39.

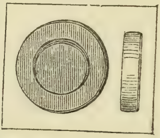
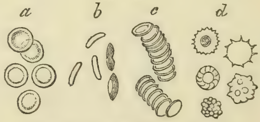


Fig. 40.



Magnified 400 diameters.

contents. Under the influence of water the red corpuscles swell up and become globular, lose their colour, and eventually disappear. Solutions denser than the blood plasma cause them to shrivel and assume irregular forms. The white corpuscles are fewer in number, but somewhat larger in size. They have a granular aspect and contain one or more nuclei.

Examination of Blood Stains.—Blood stains on linen:—Before applying the tests, note should be made of the article of dress, and the position and number of the stains; whether the stains are on the inside or outside of the garment; and, if one or more articles of dress are stained, whether they are in a corresponding part.

Blood stains have certain characters recognisable without extraneous aid. A spot of blood not disturbed by contact or friction feels like thick gum or starch. Small spots are circular, large spots approach that form; large and small alike have a defined and abrupt margin.

Arterial blood has a bright red colour, and venous blood a dark or purple hue, but it becomes arterial on exposure to the air. After the lapse of a few hours, both kinds of blood lose their bright colour and assume a reddish-brown hue, which may remain unchanged for years. When it has assumed this colour we cannot give any opinion as to its age.*

Certain of the above-mentioned tests are at once applicable to the stains, before proceeding to apply others. A small stain or part of a stain, if only one exist, may be cut out and tested with liquor ammoniæ. This will at once distinguish blood from vegetable colouring matters. To a similar fragment (a single fibre will suffice) let a drop of tincture of guaiacum and a drop of peroxide of hydrogen be added on a slide. If blood colouring matter is present, a sapphire blue colour will result. If the stain is dry, this reaction does not take place till the texture has become moistened. The other tests, with the exception of the hæmin test, which is perhaps more conveniently applied before solution, require the solution of the colouring matter. A small scraping of the stain is to be laid on a slide, a crystal of chloride of sodium added, and then boiled with glacial acetic acid in the manner before described. As already stated, the production of hæmin crystals is the best proof of the existence of blood. If we use a solution of the stain, it is best made in a solution of common salt (1 in 200). The stain is to be cut out and suspended by a thread in a test-tube or watch-glass

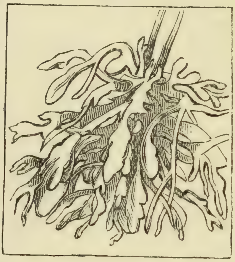
* Dr. Pfaff has suggested a solution of arsenious acid (gr. j to ℥ij) as a blood solvent and means of ascertaining the age of a stain. He thought that he could fix the age by the quicker or slower solution of the colouring matter. His own loose statements as to the time required sufficiently condemn his not very promising proposal.

containing a small quantity of the saline solution. A recent stain so treated, generally yields a reddish or reddish-brown solution, the colour being more intense in the deeper strata. An old stain gives up its colour very slowly and imperfectly, the process taking many hours. The solution may be aided by tearing the fibres of the cloth and by agitation. If the stain is very old and all the colouring matter converted into hæmatin, it will not dissolve in water; but it may be dissolved out more or less completely by ammonia.

The cloth from which the solution has been made may be examined with the microscope for the presence of adherent blood corpuscles and threads of insoluble fibrin (see fig. 41) which may remain after the colouring matter has been dissolved.

When the solution has been allowed to settle, the superficial layer of fluid may be drawn off with a pipette, and the deep layer examined for blood corpuscles. These, though quite characteristic if obtained, are rarely to be found in old stains. Occasionally the white corpuscles may be seen when the red have all disappeared. Care must be taken not to confound with blood corpuscles the torula cells which are frequently met with in old blood stains.

Fig. 41.



After Gulliver.

After the microscopical examination, the solution should be submitted to the micro-spectroscope, which, as already stated, enables us to determine the presence of the absorption bands and the reducibility of the solution with excessively small quantities. The other chemical tests may then be applied if necessary to small quantities of the coloured solution.

By the above tests, single or combined, blood stains can, as a rule, be readily identified.

Iron moulds on linen have, as in a case related by Devergie, been mistaken for spots of blood; but the distinction is easy. If the stains are not very old cold water dissolves the colouring matter of blood more or less completely, but does not affect the iron mould. Hydrochloric acid dissolves out the iron mould, which may be recognised by its appropriate tests; but does not dissolve blood-stains whether recent or old. Stains due to blood, if not soluble in water give up their colour to ammonia, but not readily.*

* Bloxam finds that old stains dissolve if heated with water in sealed tubes up to 300° F. (Bowman's 'Medical Chemistry,' p. 14).

Blood Stains on Floors, Furniture, &c.—Blood that has spouted from an artery on to a wall forms a stain resembling in shape a "point of exclamation" owing to the subsidence of the fluid to the lower end and its coagulation there. The vertical, or the more or less oblique, direction of the spot, may indicate the position of the wounded vessel. A stain similar to that of an arterial jet may, however, be caused by the splashing of blood on to the walls or furniture.

Blood-stains on carpets, &c., may often be detected by bringing a lighted candle to bear on the surface. At the proper angle of incidence the blood-stain may be recognised by its shiny surface, and a scratch with the nail causes on it a vermilion streak. The stains can be examined as if they were stains on linen.

Wood may be shaved off and immersed in water or salt solution, or the stain may be scraped, and the solution made. If the stains are on articles which cannot be immersed, cut, or scraped, a solution may be obtained by placing on the stain moistened filtering paper. This absorbs the colouring matter, and may be used for testing. In applying the guaiacum test to blood colouring matter on filtering paper, it should be borne in mind that some specimens of Swedish filtering paper give of themselves the ozonic reaction.

Blood-stains on articles of steel and iron are readily identified when they present themselves as clots on a clean bright surface of metal. They are then of a clear red, or reddish-brown colour, are easily detached, and scale off under a moderate heat. The presence of animal matter in the spots is readily ascertained by heating them in a reduction-tube, when ammonia is given off, and identified by its alkaline reaction on turmeric paper. A small particle of blood-crust is sufficient for this purpose. The crust placed in a few drops of distilled water will, after a time, yield a reddish-brown solution and the reactions already described; and if placed under the microscope, will be found to contain blood-globules.

If the blood is smeared on the instrument it will not scale off when heated. The stain must be moistened with distilled water, and carefully scraped off and examined chemically and with the microscope.

If the instrument has been some time exposed to air and moisture, spots of rust will be mixed with those of blood. In this case, too, the stains are not detached by heat, and it will be necessary to scrape them off, place them in distilled water, and separate the insoluble particles of rust by filtration. The resulting coloured liquid will have the chemical and microscopic

characters of the blood solution. As, however, the blood colouring matter forms a very insoluble compound with oxide of iron, water may not dissolve it, in which case dilute caustic soda will form a dichroic solution of alkaline hæmatin. Or the mixed blood and rust may be scraped off, heated in a tube with soda or potash, dissolved in water and treated with the mixed sulphates of iron and then with hydrochloric acid; Prussian blue will be formed. Rust alone so treated does not give this reaction.

Two other kinds of spots on articles of steel or iron have been pointed out as liable to be mistaken for spots of blood—spots of rust, and spots produced by lemon-juice, vinegar, or other vegetable acid.

Spots of rust somewhat resemble blood-spots in colour, but they do not scale off, and are not soluble in water. If thick enough to be detached, they are readily separated by filtration, leaving the water quite clear, and not affected by the tests for iron. A drop of hydrochloric acid placed on the spot of rust dissolves it, and leaves the metal clean, and on diluting the solution with distilled water, the presence of iron may be detected by appropriate tests.

Spots of lemon-juice have been mistaken for those of blood. A man was suspected of a murder, and a knife, apparently covered with blood, was found in his possession; but on examining it the spots were found to be due to citric acid. The instrument had been used some days before for cutting a lemon, and had been put by unwiped (Orfila).

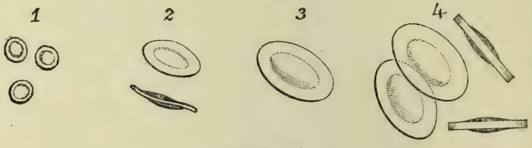
The thinner spots produced in this way have a reddish-yellow, the thicker a reddish-brown, colour, nearly resembling that of blood, and they separate, like blood-spots, when moderately heated. When heated in a tube they give off a volatile matter, which has an acid reaction—spots of blood have an alkaline reaction. The solution in distilled water is light yellow—that of blood is red; it sometimes has an acid reaction—that of blood is neutral, or faintly alkaline; with infusion of galls it yields a black precipitate, a blue with the ferrocyanide, a rich cherry red with the sulphocyanide, of potassium. Blood yields a red precipitate with the first test, and is unaffected by the others. The oxide of iron is thrown down by alkalies.

It having been clearly made out that the stain we have been examining is a blood-stain, three questions may arise: 1. *Is it human blood, or that of an animal?* 2. *From what part of the body did it flow?* 3. *What is the age of the stain?*

1. *Human Blood and that of Animals.*—Two means of diagnosis have been proposed, the one microscopic, the other chemical.

Diagnosis by the Microscope.—The only means of distinction under the microscope is afforded by certain well-known differences in the shape and size of the corpuscles. The human blood-corpuscle, depicted in fig. 40, p. 331, is a circular flattened disc; and that of mammals, with the exception of the camel tribe, has the same form. The only appreciable difference is in the size of the globules. In man they measure on an average $\frac{1}{3200}$ of an inch; in animals the diameters vary from $\frac{1}{3540}$ to $\frac{1}{6366}$. But these are only averages; and the extreme measurements which in man may be stated at $\frac{1}{2000}$ and $\frac{1}{4000}$, lie, in some animals, still wider apart. When it is borne in mind that, in most instances, we have to examine a blood-solution obtained from dried blood, made to approximate to the average density of blood by the addition of syrup, glycerine, or salt; that the size of the globules is materially affected by the density of the medium in which they float; and that in the blood itself the diameter of one globule may be twice as great as that of another, it is scarcely to be expected that the most skilful and practised person should be able to distinguish human blood from that of other mammals.* But the nucleated blood-corpuscles of birds, reptiles, and fishes, differ so widely in size and shape from those of man and animals, as to enable us to state positively that the blood in a given case is either that of a mammal, or belongs to one of the three classes of creatures just specified. The differ-

Fig. 42.



× 400 Diameters.

* Dr. J. G. Richardson, of Pennsylvania,[1] however, contends that with the use of high powers ($\frac{1}{25}$th to $\frac{1}{50}$th in. objective), and careful micrometric measurements it is possible under favourable conditions to distinguish positively between the blood corpuscles of man and those of many at least of the domestic animals. Though he admits that it is not possible to distinguish from the human corpuscle that of any animal which measures more than $\frac{1}{4000}$ in., yet he argues that the minimum size of the human corpuscle ($\frac{1}{3621}$ in.), is so much above the average of the pig ($\frac{1}{4230}$ in.), the ox ($\frac{1}{4267}$ in.), the red deer ($\frac{1}{4324}$ in.), the cat ($\frac{1}{4404}$ in.), the horse ($\frac{1}{4600}$ in.), the sheep ($\frac{1}{5300}$ in.), the goat ($\frac{1}{6366}$ in.), that the distinction may be made.

[1] 'Amer. Jour. of Med. Sciences,' July, 1874, and various other memoirs.

ences of size and shape are shown in the annexed woodcut, in which (1) is human blood, (2) the blood of the common fowl, (3) the blood of the frog, and (4) the blood of a fish. (For some minute details of measurements in Mammalia, see 'Micrographic Dictionary,' Art. Blood, and Plate 39 of that work).*

Chemical Diagnosis.—Barruel first proposed to distinguish the blood of different animals by the characteristic odour given off on adding sulphuric acid. If this acid, diluted with half its bulk of water, is added to the blood of an animal, an odour is perceived which closely resembles that of its perspiration; and probably persons would recognise the odour if informed of its existence, and equally probable that they would be mistaken if asked to name the animal which had supplied the blood.

I make this statement as the result of experiments with fresh blood of different animals, in such quantity as a drachm or more, made in the class-room for several years in succession. The majority have always been wrong in their guesses; but on one occasion, a member of my class was uniformly right in his opinion, though the experiment was so devised as to preclude mere guessing. As a means of distinguishing spots of blood, or solutions obtained from them, this test must certainly be disallowed. It has utterly failed in the hands of very competent persons (G.).

2. It has already been stated that we possess no means of distinguishing menstrual blood from blood from a wound, further than that the nature of the dress, and position of the blood upon it, along with the occurrence of epithelial scales (squamous and cylindrical), may assist us.

In some cases spots submitted for examination are found blended with hair, skin, or mucous membrane, or with other matters adhering to the material on which the blood has fallen. The discovery of such admixtures may often supply very important medico-legal information.

Hair on Weapons.—Weapons which have inflicted wounds are generally blood-stained, and we may often discover hairs adhering to the blood-clots, or otherwise attached to the weapon, and it is very important to determine whether the hairs are human hairs or not, and whether they correspond to the hairs on the body of the person who has been wounded; and for this purpose a careful comparison will have to be made of the hairs found on the weapon

* The crystals of hæmaglobin which may be obtained from *fresh* blood in some animals by mere evaporation, in others with greater difficulty by the aid of ether, freezing, thawing, &c., differ in different mammals, those of the guinea-pig being tetrahedral, those of the squirrel being hexagonal, the common form being rhombic prisms, but this fact scarcely admits of being applied to medico-legal purposes.

with those on the body of the deceased. Hairs must not be confounded with fibres of cotton, linen, wool, or silk. Fibres of cotton have a twisted appearance, those of linen have a tapering jointed structure, those of silk are smooth, and those of wool have a peculiar spiral-like imbrication. (Fig. 44).

Hair consists of a cortical and medullary substance, covered by an imbricated cuticle. When the hair is young and soft, the medullary portion may be absent, and the whole hair has a fibrous appearance. The dark, irregular appearance of the medulla, the striated cortical substance, and the peculiar imbrication of the cuticular scales, render hair easily recognisable. The hairs of the head are usually truncated or split at the free end, while those of the body are, as a rule, pointed, and occasionally this difference may enable us to determine the origin of the hair. The hair of the lower animals differs from human hair in several respects. In many animals the hair is entirely cellular, in others there is a combination of the cellular with the fibrous structure. Examples of both kinds are given in the accompanying woodcut (p. 339), which may serve as standards of comparison both as to appearance and size.

Brain Substance on Weapons.— Occasionally on weapons which have caused fracture of the skull and laceration of the brain, portions of brain-substance are found. When fresh, it is not easily mistaken; when dry it becomes grey or brown, and horny. When moistened, it assumes a whiter colour, and a soapy consistence. Attempts have been made to recognise brain-substance by its reactions with sulphuric and hydrochloric acids; but they are not satisfactory, and may mislead. The only satisfactory method of detection is by the microscope. When the matter is softened in distilled water or in solution of salt, the presence of nerve cells or of nerve fibres may be ascertained. These are small ($\frac{1}{8000}$ inch or less in diameter) generally ampullated (Fig. 43), or they may have been disorganized and only myelin drops may remain.

Fig. 43.

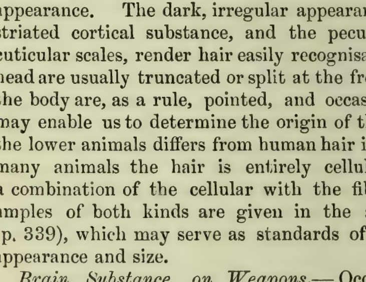
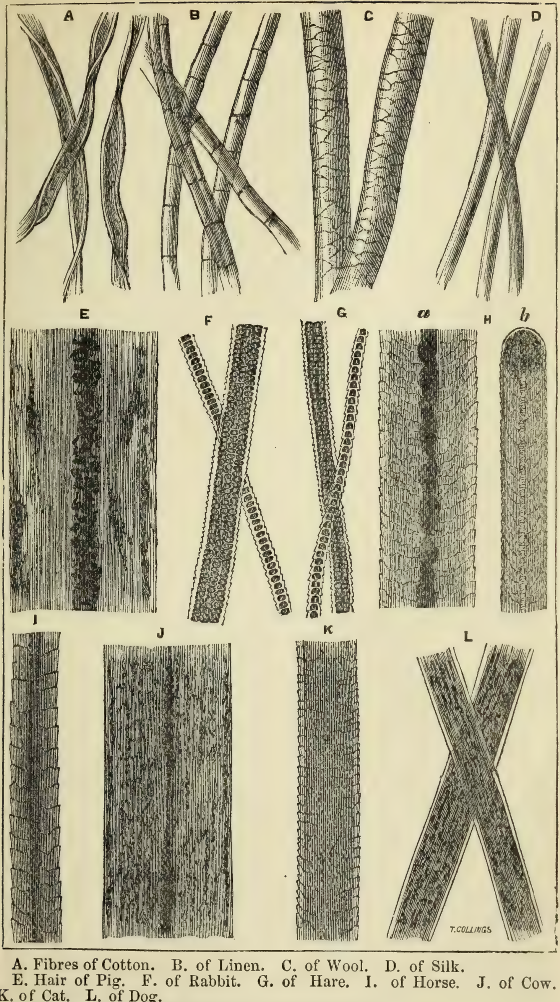


Fig. 44.



A. Fibres of Cotton. B. of Linen. C. of Wool. D. of Silk.
E. Hair of Pig. F. of Rabbit. G. of Hare. I. of Horse. J. of Cow. K. of Cat. L. of Dog.
H. Human hair. From head (*a*): from body (*b*).

CHAPTER IV.

DEATH BY FIRE—SPONTANEOUS COMBUSTION—DEATH BY LIGHTNING—BY COLD—BY STARVATION.

DEATH BY FIRE.

DEATHS by burns and scalds are of frequent occurrence, and the greater number are due to clothes catching fire, a smaller number to conflagrations, and to explosions of gunpowder, fireworks, and gases. A considerable number of deaths due to scalding liquids are entered in our death registers, under "Burns and Scalds," and about fifty deaths in the year are caused by drinking hot water.

The cause of death by burning is not always the same. Some are suffocated by smoke; others die frightened, or by blows from falling bodies; others by the shock that follows extensive injury to the tissues; and others, again, at periods more or less remote from the burning, by collapse, or the effects of inflammation. Children not unfrequently die in a state of coma from severe burns, owing to congestion and serous effusion in the brain, and a frequent cause of death after burns is inflammation of serous or mucous membranes. The duodenum, according to the observations of Curling,* is especially apt to be so affected. The danger from burns and scalds is in great measure proportional to the extent of surface injured.

The appearances produced by burning consist of blisters, entire or burst, roasted patches, sooty spots and marks from burnt articles of clothing, and singed hair.

The same medico-legal questions arise in reference to death by fire as in other forms of external injury, except that the alternative

* 'Med. Chir. Trans.,' vol. xxv.

of suicide or homicide rarely presents itself. Both burns and scalds are rare suicidal and homicidal acts. In cases of murder, the marks on the body would show that the burning was inflicted during life; but as a murderer sometimes resorts to burning to conceal the real mode and cause of death, we may have to distinguish burning during life from burning after death. Again, when a body is found with marks of burning too extensive to be explained by the quantity of fuel consumed, it may become a question whether it was unusually combustible or had undergone a process of "spontaneous combustion."

Burns inflicted during life and after death.—The distinction between burns and scalds inflicted before and after death has been made the subject of numerous experiments by Sir R. Christison, Casper, Champouillon, Chambert and others. As a general result of these experiments, it may be stated that the indications of a burn inflicted during life are the presence of vesications and the signs of inflammatory reaction. If these are not present, which may be the case, even though the burns have been inflicted during life, we have no means of distinguishing the one from the other. The vesicles, which appear immediately or after a varying interval, contain serum which either coagulates in mass, or yields a copious precipitate of albumen when heated or acted upon with nitric acid.

Surrounding the vesicle there is a deep red line which remains after death, and which is a characteristic sign of vital reaction, though it is not always present, as death may occur before it shows itself.

When the cuticle is removed, the skin underneath is found reddened, and dotted by the deep red openings of the sudoriferous and sebaceous ducts. The redness also extends into the subcutaneous tissues. This reddened base of the vesicle is the most valuable indication of a burn inflicted during life, as it will be found where there is no red boundary line. It is scarcely necessary to add that redness follows instantly on the application of heat, and that vesicles show themselves after the interval of a few seconds.

On the other hand, in post-mortem burns vesicles are produced, if at all, with great difficulty. If they do form they either contain only air, or, if a fluid, one which contains little albumen, and becomes only opaline or milky when heated, or on the addition of nitric acid. The base is not red, but the surface of the skin is of a dull white, dotted with grey at the orifices of the cutaneous ducts. There is no red boundary line. These post-mortem vesicles are most readily produced in anasarcous subjects. Vesicles

caused by putrefaction are readily distinguished by the absence of these appearances, the exposed true skin being like that of adjacent parts, colourless or green.

The appearances just described as due to the application of heat to the living body, are common to all intense inflammations of the skin, whether due to disease, or caused by the application of cantharides and other strong irritants, by pressure, or by friction. I have seen on the ankles of a young man who had died of acute phthisis, two patches of inflammation of a deep red colour not removable by pressure, and with well-defined margins, on one of which were large vesicles containing serum. I ascertained beyond doubt that the spots, which had been observed during life, were not caused by the application of any heated body (G.). Appearances simulating burns also precede the acute bed-sore of certain cerebral and spinal affections.*

In all these cases of acute cutaneous inflammation, a thin vertical section of the inflamed skin and underlying tissues displays, even to the naked eye, distinct red patches, contrasting very strikingly with similar sections of skin discoloured by mere subsidence of the blood.

The diagnostic marks just described have a distinct bearing on those rare cases in which, as in that of Bolam, tried at Newcastle in 1839, arson is resorted to to conceal the true cause of death.

Of the question of *accident*, *suicide*, or *homicide*, it must suffice to observe that suicides and homicides by fire are very rare; and that the suicidal cases occur chiefly among persons of unsound mind.

SPONTANEOUS COMBUSTION.

The following case, which rests on the authority of Le Cat, a firm believer in spontaneous combustion, forms a fitting introduction to this subject. It is said to have taken place in 1725:—

One Millet, of Rheims, was charged with the murder of his wife, the remains of whose body were found lying near the kitchen hearth on the floor, which was partially burnt. Parts of the head and lower extremities, and a few of the vertebræ, had escaped combustion. Millet stated that he and his wife had retired to rest the previous evening, but that she not being able to sleep, got up and went into the kitchen, as he supposed to warm herself; that he was aroused by the smell of fire, and going down stairs, found the deceased lying in the manner stated. The prisoner was condemned to death, but, on appeal to a higher court the case was

* Consult Charcot, 'Diseases of the Nervous System.' Syd. Soc. Trans. 1877.

pronounced one of spontaneous human combustion, and the sentence was revoked.

In this case the extent to which the body was consumed gave some support to the opinion that it was unusually combustible, but none to the notion that the fire originated in the body itself. It was certainly in the most favourable circumstances for being *set on fire;* and this is true of most of the cases attributed to spontaneous combustion in England and abroad.

Orfila testifies his belief in spontaneous human combustion by thus describing the phenomena that accompany it:—A light blue flame not readily extinguished by water, but even increased by it, appears over the part about to be attacked, followed by deep eschars, accompanied by convulsions, delirium, vomiting, and diarrhœa. A peculiar state of putrefaction ensues, which soon proves fatal. The process is said to be extremely rapid, but the body is never quite consumed: some parts are only half burnt, while others are reduced to a carbonaceous, fœtid, unctuous ash. The trunk is usually consumed, but the hands and feet escape. The clothes are commonly destroyed; but articles of furniture standing near, escape. A thick greasy soot covers the walls and furniture, and the air has an offensive empyreumatic odour. The phenomenon is stated to occur chiefly in aged corpulent females, and especially in persons long addicted to the abuse of spirituous liquors.

It is practically of little consequence whether the doctrine of spontaneous combustion be true or false. The cases* recorded create a presumption in favour of an unusual combustibility of the body, occurring in rare instances, and for the most part, in corpulent spirit-drinking females, merely requiring to be set on fire, and needing no other fuel but their clothes, night-dress, or ordinary bed-furniture. Till we possess further cases better authenticated and more accurately reported, we must rest content with this amount of knowledge, not forgetting, meanwhile, that such men as Liebig and Casper treat the very notion of spontaneous combustion as an idle fable, stamped with the brand of sheer credulity, and one opposed to such simple facts, among others, as that the human body contains 75 per cent. of water.

The spontaneous combustion of inorganic substances, a subject of much interest and importance, has no medico-legal bearing.

* Jacobs, as cited by Casper, has brought together 28, of which 20 occurred in France; and A. Ogston* has reported the particulars of a case in which the extent of destruction of the body seemed quite out of proportion to that of the surroundings.

* 'Brit. and For. Med. Chir. Review,' Jan. 1870.

DEATH BY LIGHTNING.

About a score of deaths by lightning occur, one year with another, in England and Wales; of 21 deaths, 18 took place in males and 3 in females. It is a mode of death that rarely gives rise to medico-legal questions; but as the effects of lightning on the body often resemble those caused by mechanical violence, a question might arise, whether a person found dead under unknown circumstances, had perished by lightning or had been murdered.

In most cases we have a clue to the cause of death in the fact that a thunder-storm has taken place, and that the corpse is found in such a situation, and with such surroundings, as is consistent with its having been struck by lightning.

As a general rule it may be stated, that the electric current prefers good conductors; and as the human body is a very good conductor, it is as likely to be struck as any object similarly situated, unless, perhaps, that object be of metal.

As a general rule, too, lofty objects are most likely to be struck; but persons have been struck in the immediate neighbourhood of tall trees which have been uninjured; and in woods it is not always the highest trees that are struck. The electric discharge is often conducted to the body by such lofty objects as trees, masts, the rigging of ships, and the moist strings of kites. The danger of remaining under a tree during a storm is proverbial.

It has been thought that a person is tolerably safe in an open space far from any object which could attract the electric discharge, but this is an error. The human body may be, in these circumstances, the most prominent object and also the best conductor.

Death may be caused by an electric discharge, other than the descending lightning stroke. This happens when a cloud near the earth is negatively electrified, while the earth is positive, and the human body serves as the conductor, by which the equilibrium is restored. This is called the *ascending* or *returning stroke.*

The violent mechanical effects produced by the electric discharge —the disruption of buildings and removal of parts of them to a distance; the rending of trees into laths; the separation of good conductors from bad ones; the fusion of metallic substances; the ignition of inflammable ones; the magnetic properties communicated to articles of iron and steel—are familiarly known.

The *Post-mortem Appearances* in bodies struck by lightning are very various. Sometimes no marks of injury are found, and this is said to occur most commonly in death by the *returning stroke.* In other cases the body is bruised or torn at the spot

where the electric current has entered; or there is merely a small round hole at the point of exit. Extensive bruises and livid streaks are sometimes present, most frequently on the back. Occasionally also metallic chains are fused, causing local burns, and metallic streaks on the skin. Fractures of the bones are rare: they may occur, as Ambrose Paré states, without external wound. A case of extensive fracture of the bones of the skull is related by Pouillet. Marks of burns and singeing are sometimes, present. They may occur even when the clothes have not been set on fire.

Hunter was of opinion that in death by lightning there was an absence of rigor mortis, that the blood did not coagulate, and that putrefaction was hastened. These statements are not, however, in accordance with other observations in death by lightning; persons killed by lightning being sometimes found rigid in the position in which they were struck. And Richardson's experiments on animals show that well-marked rigidity comes on in death from electrical discharges. The blood seems to coagulate more slowly than usual in these cases, but the course of putrefaction does not seem influenced in any appreciable manner. These points are worthy of note; but even should the blood be fluid, rigidity absent, and putrefaction hastened, these are not peculiar to death by lightning, for they may all coincide in other modes of sudden death.

In some cases the state of the objects found on the corpse, or belonging to it, furnish complete evidence of the cause of death. The clothes may be torn and burnt; the shoes struck from the feet; metallic bodies fused and forcibly carried to a distance; and articles of iron or steel, such as the steel of the stays, or the main-spring of a watch, rendered strongly magnetic.*

Cause of Death.—The electric discharge acts chiefly through the nervous system, and the cause of death is the shock or disruption sustained by it. When not immediately fatal, its action on the brain, spinal marrow, or nerves, is shown by loss of sight, and various affections of sensation, or voluntary motion, temporary or permanent.

DEATH BY COLD.

This is an uncommon event in this country, though death by cold and inanition combined is not very rare in severe winters.

* A full description of the effects of lightning will be found in Dr. Sistier's work, 'De la Foudre.' Paris 1866. See also an interesting series of experiments on animals with powerful electric discharges, by Dr. B. W. Richardson, 'Med. Times and Gaz.,' May, August and September, 1869.

The first effect of intense cold is a sense of numbness and stiffness in the muscles of the limbs and face. This is soon followed by torpor and profound sleep, passing into coma and death.

The effect of cold on the circulation is to drive the blood from the surface to the interior of the body, so as to gorge the spleen, liver, lungs, and brain. The genital organs are also congested, sometimes giving rise to priapism. The temperature of the blood itself is lowered; the heart contracts slowly and feebly, and the pulse is small and weak. The congestion of the nervous centres occasions numbness, torpor, somnolency, giddiness, dimness of sight, tetanus, and paralysis; and the congestion of the brain sometimes occasions a species of delirium, as happened to Edward Jenner; or the appearance of intoxication, as witnessed by Captain Parry and others in the expeditions to the North Pole.

The effect of cold varies in intensity with sex, age, and strength: the very young, the aged, the infirm, persons worn out by disease and fatigue, and those addicted to the use of intoxicating liquors, perish soonest. Some persons, too, have a great advantage over others in their power of resisting cold—a fact frequently observed by voyagers and travellers in the Arctic regions.

In estimating the effect of cold, it should be borne in mind that the body is cooled in three ways—by evaporation; by conduction of the air in contact with it; and by radiation.

The cutaneous evaporation is increased by dry and diminished by moist air. Hence the body parts with its heat more rapidly in a dry atmosphere. On the other hand, the body is cooled by conduction, when the air is moist; so that the body is cooled alike by dry cold air and by cold moist air. Cold humid winds lower the temperature in a very striking degree, by evaporation and by conduction. The effect of a slight breeze in increasing the sensation of cold has been remarkably shown in the expeditions to the Polar seas.

Post-mortem Appearances.—The appearances after death by cold still require investigation, but the following have been found by Ogston * uniformly present in adults. A florid or arterial hue of the blood, except when in mass; an over distension of both cavities of the heart and all the large vascular trunks; a notable pallor of the skin generally, but here and there dusky red patches on non-dependent parts. He found also, as a rule anæmia of the viscera most largely supplied with

* 'Lect. on Med. Jurisp.,' p. 556.

blood. In ten cases he found moderate congestion of the brain in three, and of the liver in seven. Other observers have, however, described the viscera as being congested. In two cases reported by Dr. Kellie, of Leith, there was a large effusion of serum in the ventricles of the brain. Though the appearances described by Ogston seem to be the most reliable and uniform, further investigations will be necessary before we can consider them as altogether characteristic and conclusive of death from cold.

The question of accident, suicide, or homicide, rarely finds place in this mode of death ; but, in one singular and horrible case, death by cold was a homicidal act. A girl, 11 years of age, a few years since, was compelled by her parents to stand naked in a pail of ice-cold water, while the water was being poured over her till she died.

DEATH BY STARVATION.

This is a very rare event; but death from cold in persons insufficiently nourished is not infrequent. Cases of homicide by the deprivation of food, are of occasional occurrence;* the insane sometimes commit suicide by obstinately refusing to take sustenance; some prisoners under long sentences would starve themselves if not fed by force.

The Symptoms produced by Protracted Abstinence are pain in the epigastrium, relieved by pressure, with intense thirst, and extreme weakness and emaciation. The face is pale and ghastly; the cheeks are sunken; the eyes hollow, wild, and glistening; the breath hot; the mouth dry and parched; the bones project. The body at length exhales a fœtid odour, the mucous membranes of the outlets become red and inflamed, and death takes place in a fit of maniacal delirium, or in horrible convulsions.

From Willan's case, presently to be cited, and the statements of prisoners who have voluntarily abstained, it appears that the craving for food disappears in about three days, and that the second day of abstinence is that of greatest suffering (G.)

Post-mortem Appearances.—The body is much emaciated, and exhales a fœtid odour; the eyes are red and open, the skin,

* The Penge case (Cent. Crim. Court, Sept. 1877) involved a charge of homicide by starvation against four persons. The prisoners were convicted of murder, but owing to objections urged against the validity of the medical evidence for the prosecution, the sentence was commuted. For an account of the post-mortem appearances, and discussion of their significance, see the 'Brit. Med. Journ.,' Oct. 6, 1877, *et seq.*

mouth and fauces dry, the stomach and intestines empty and contracted, so as to be quite translucent; the gall-bladder is distended with bile; the heart, lungs, and large vessels are collapsed, bloodless and attenuated; and putrefaction runs a rapid course. These appearances are not so characteristic as to be decisive of the mode of death; but in the absence of any disease productive of extreme emaciation, such a state of body furnishes a strong presumption of death by starvation. It must be recollected, that there are maladies such as stricture of the œsophagus, and organic disease of the stomach, tubercular disease, diabetes, Addison's disease, &c., which prove fatal by starvation or malnutrition. Search should, therefore, be made for such causes of death.

The post-mortem appearances were faithfully described by Mr. Biggs in the case of Mark Cornish, killed by starvation and exposure by his father and step-mother.* He stated at the inquest that the deceased was so wasted that he had scarcely any muscle left, and no fat; that he looked like a skeleton with the skin tightly stretched over him; that he could not only see each bone but its peculiarities; that all the organs were healthy, though the heart and stomach were small; that the *omentum* was as clear as glass; that there was no food in the stomach; that the small intestines were nearly empty; and that there was no appearance of chyle.

The period at which death happens, varies with age, sex, strength, and amount of exertion, and especially with the supply of water.

The question how long a person may remain without food, or with a very scanty supply of it, is of some importance, as will appear from the case of Elizabeth Canning, quoted in Dr. Cumming's Lectures.† It was alleged that a girl of eighteen had been confined, in the depth of winter, twenty-eight days, without fire, with about a gallon of water in a pitcher, and with no food but some pieces of bread, amounting altogether to about a quartern loaf, and a small mince pie which she happened to have in her pocket, and that at the expiration of the period she retained strength enough to break down a window-shutter fastened with nails, get out of the window on to a sort of pent-house, thence jump to the ground, nine or ten feet; and finish by walking from Enfield Wash to Aldermanbury.

The cases presently to be cited give good ground for believing that life might have been prolonged for twenty-eight days, or

* 'Morning Chronicle,' February 26, 1853.
† 'Medical Gazette,' vol. xix.

even more, on this scanty supply of nourishment; but it is extremely inprobable that, at the end of this time, Elizabeth Canning could have had strength enough left to effect her escape. This case is also curious in its bearing on the question of identity. A fresh interest has been given to this question of prolonged abstinence by the case of Sarah Jacob, the Welsh Fasting Girl.

There are four distinct classes of cases which may be used to throw light on this question of the duration of life under complete, or nearly complete deprivation of food. 1. Mechanical obstruction of the gullet. 2. Shipwrecked persons subject to exposure and fatigue. 3. Persons buried, and rendered inactive, by such obstructions as falling earth. 4. Persons wilfully abstaining from food; generally under circumstances demanding little exertion of mind or body.

1. For an interesting case of this class we are indebted to Dr. Currie, of Liverpool. A man, 66 years of age, survived a complete obstruction of the gullet (with the aid of nutritious clysters and baths of milk-and-water administered during 32 days) for 36 days. The man, who was tall and corpulent, was reduced from an ascertained weight of 240 lbs. down to 138 lbs.—a loss of 102 lbs., of which two-fifths took place in the space of 32 days, for his weight before the complete obstruction of the gullet was 179 lbs. In the last twelve days he lost 16 lbs., or at the rate of $1\frac{1}{3}$ lb. per diem; and this loss the already wasted frame sustained in spite of the nourishment administered in the mode just described. What the unchecked rate of waste would have been we have no means of ascertaining; but we know that death took place when the body had lost 102 lbs. out of 240, or little more than two parts in five of its original weight—a reduction corresponding most closely to the results of Chossat's experiments on animals. He laid it down as a broad principle derived from experiments on many different living creatures, that life ceases when an animal loses two-fifths of its weight. So that an animal weighing 100 lbs., would die when its weight was reduced to 60 lbs. Though life may cease before this point is attained, and the period varies greatly in different classes of animals, it can rarely extend beyond it. The daily loss amounts to one-twenty-fourth of the entire weight—a statement in harmony with the conclusion of Bidder and Schmidt, that an animal, to maintain its weight, ought to take one-twenty-third part of it daily in the shape of food susceptible of being assimilated, water of course included. But, if we assume a man to weigh 230 lbs., the daily supply will reach the most unlikely quantity of 10 lbs.

The progressive and rapid waste of the body, and the extinction of life at or about the point at which an animal loses two-fifths of its weight, may therefore be taken as data sufficiently established; as also the fact, long since proved by Redi, that animals live much longer (birds more than twice as long) when they have free access to water.

2. Of the prolongation of life under the fatigues, exposure, total privation of food, and want of fresh water (except such as may have been supplied by dew or rain) incidental to shipwrecks, we have some well-authenticated cases. A narrative of a shipwreck on the Calcutta coast which has been placed at my disposal, shows that out of 13 men without food or water 12 days, three died, the rest escaped and recovered (G.). And a very detailed and evidently faithful account of the picking up at sea of Captain Casey, commander of the *Jane Lowden,* timber vessel, shows that out of 18 men, including the captain himself, wholly without provisions and fresh water, one survived 11 days, one 12, one 14, two 15, one 18, and the captain himself, who recovered, 28 days. Two men appear to have died early, furiously delirious, one (a lad, æt. 19) who died on the 12th day, was quietly delirious, with spectral illusions; two others were delirious, and Captain Casey had illusions of hearing.*

3. Of confinement in coal mines, we have instances of men and boys surviving 6 and 8 days, and one man 23 days.† There was access to water for the first ten days.

4. The longest abstinence from food, with free access to water, of which I have had experience among prisoners, is ten days. In two men and one woman, complete abstinence from food during this period was followed by no bad symptom, and the ordinary prison diet was resumed without injury to health. The prisoners were weakened, but by no means exhausted (G.). In the case of ten days' starvation of a prisoner reported by Casper, scarcely any liquid was taken, and the exhaustion was much greater.‡

The case of Bernard Cavanagh, though not one of complete abstinence, may be added to the foregoing. Having been committed to gaol for three months, he was placed in a cell under strict surveillance, and refused to eat or drink. This continued, as it was alleged, nine days, at the end of which time he was reported to be in "perfect bodily health." But on the 13th day, it was remarked that the gruel supplied to him came back

* The 'Times,' February 7, 1866.
† Dr. Sloan, 'Med. Gaz.,' vol. xvii. pp. 264 and 389.
‡ 'Hand-book,' vol. ii. p. 28.

the same in quantity, but much thinner. The man's health having by this time suffered, he was supplied with, and gladly received nourishing food.*

But we have well-authenticated cases extending much beyond ten days. There is Hufeland's curious case of the ruined merchant, a suicide by starvation, who kept a diary of his sensations for 13 days, and died on the 18th (G. H. Lewes' 'Physiology of Common Life,' vol. i. p. 25); the case of Viterbi, who survived 21 days; of Cecilia Rygeway, reported to have survived 40 days; and a case of 42 days briefly attested by Van Swieten. The first of these two cases is thus epitomized by the author of an article on Fasting Girls, published in 'All the Year Round,' Oct. 9, 1869. "Cecilia de Rygeway, having been imprisoned in Nottingham jail for the murder of her husband, during the reign of Edward III. (the year 1357), remained 'mute and abstinent' for 40 days, neither eating nor drinking during this time. It was considered so much in the nature of a religious sign or miracle that Dame Rygeway was pardoned by the King." The second case is briefly mentioned by Van Swieten in his 'Commentaries on Boerhaave's Aphorisms' (heading, Melancholy Madness): "I knew a woman," he says, "who obstinately refused all kinds of nourishment for six weeks, drinking nothing but a little water at intervals, so that at length she perished quite juiceless and dried up."

Willan's well-authenticated and minutely-detailed case of voluntary starvation† occurred in the person of a young man, a religious maniac, who drank water and a little orange-juice, but ate nothing, and lived 61 days, and then, being cautiously fed, other 18 days. This survivorship of 61 days without food, gives an air of probability to the French case of Guillaume Granét, the prisoner of Toulouse, which was reported to the Academy of Medicine, as follows:—He resorted to starvation to avoid punishment. For the first seven days the symptoms were not very remarkable; his face was flushed, his breath foul, and his pulse small and feeble. After this period he was compelled to drink water occasionally, to relieve his excessive thirst, but in spite of

* 'Medical Times,' December 4, 1841.

† Miscellaneous works of the late Robert Willan, M.D., F.R.S., &c., edited by Ashby Smith, M.D., 1821 (p. 437). Willan, in commenting on this case, cites the following cases:—

1. 'Mémoires de l'Académie des Sciences,' 1769. A madman lived 47 days with nothing but a pint and a half of water per day. He stood constantly in the same position for 38 days of that time, but during the remaining eight lay down, and then took nothing, not even water. When he first began to eat again, he recovered his reason, but soon relapsed. 2. 'Edin. Med. Essays,' vol. vi. A young girl fasted, at one time 34, at another 54 days, from a spasm or some obstruction of the œsophagus.

the close watch kept over him, he frequently drank his urine, o the water of the prison kennel. His strength did not appear t fail him during the greater part of the time, and, with varyin symptoms of constitutional disturbance and acute sufferings, h lingered to the fifty-eighth day, when he expired, after strugglin four hours in convulsions.*

From the best authenticated cases of prolonged abstinenc whether voluntary or involuntary, we infer that though life ma be prolonged up to the limit of about two months, there is pro gressive and rapid loss of weight, and at length extreme emacia tion. If, then, it were alleged by, or on behalf of, some man woman, or child, that there had been a total abstinence from foo for some period exceeding two months; or abstinence, not fron food only, but from water also, for some such period as on month, we should be justified in looking on the case with th utmost possible suspicion, especially if the person so abstaining having anything approaching the plumpness and fresh colou belonging to health, were to assert that no action of the bowel or bladder had taken place. The making such person the subjec of exhibition, and still worse, of gain, would add indignation t doubt, and leave no alternative but to demand the decisive tes of the closest surveillance.

Two English cases, in which this severe test was applied, ar on record.—The one the Fasting Woman of Tutbury, the othe the Fasting Girl of Wales; for we pass over all cases not thu tested. Ann Moore, the Fasting Woman of Tutbury, was 5 years old in 1808, when she asserted that she had gone twent months without food. She said that four years before that dat she had a severe illness which lasted thirteen weeks, followed b incomplete recovery, for she was subject for months afterwards t violent fits and spasms at frequent and irregular intervals. A year later she had another severe illness that lasted eleven week and was followed by loss of appetite and indigestion, increased i 1806 by nursing a boy affected with a repulsive disease. Fron October in that year, to February, 1807, she ate a penny loaf i a fortnight, and drank a little tea without milk or sugar. Fron that time till November, 1808, she lived she said, only on wate and tea. The case having been published in the 'Monthl Magazine' early in 1809, created a great sensation, and led t donations of money, on which the woman lived four years. But in 1813, a few scientific men in the neighbourhood determined t sift the matter to the bottom. They got her to consent to have he

* Foderé, vol. ii. p. 276.

room guarded and watched. This was done during nine days, at the end of which time she gave in, being terribly emaciated, and now really almost starved to death. She asked for food, recovered her strength, and set her mark to a written confession, in which she admitted that she had occassionally taken nourishment during the last six years, and humbly asked pardon of God and man for the wicked deception she had practised.*

Sarah Jacob, daughter of Evan Jacob, a respectable and solvent tenant farmer, was the third child of a healthy family of seven, living in a mean-looking house, with thatched roof and clay floor, in which the girl and her parents occupied the same small bedroom. She was born May 12, 1857; her case began to attract public attention in 1867, when she was more than ten years old; and she died December 7, 1869, a little more than $12\frac{1}{2}$ years of age. She was a fair, good looking-child, intelligent and precocious, impressionable and emotional, fond of finery, and addicted to the reading of religious books, and the reciting and composing of verses. In February, 1866, when nearly nine years old, she had an attack of scarlet fever, followed by acute pain of stomach and vomiting of blood; and from this time, she was alleged to have kept her bed. The pain and vomiting were soon followed by strong convulsions, with arching backward of the body, and symptoms of pleurisy. The body remained rigid for a month, she took little food, and grew thin. In April, 1867, she was treated for inflammation of the brain, and about this time is stated to have taken no food for a month, though the lips were moistened from time to time with beer, and only scanty evacuations of either kind were passed. After the inflammatory attack she lost her hair. The fits, which had been convulsive, now changed to short losses of consciousness, with sudden wakings and throwing about of the arms; and the left leg was stated to be rigid. On the 10th of October of this year (1867), she is said to have ceased to take any kind of food, on the 6th of the following month to have had the last discharge from the bowels, and at the end of it to have passed urine for the last time.

We glean from the detailed accounts of the case, that the father asserted, and the public were asked to believe, that this girl took no food whatever for two years and two months, and the last

* This history of Ann Moore is a further abbreviation of the abstract given in 'All the Year Round.' The account of the Welsh Fasting Girl is taken from Dr. Fowler's work, which derives a special interest from the prominent part played by its author in the case from first to last. 'A Complete History of the Case of the Welsh Fasting Girl (Sarah Jacob), with Comments Thereon; and Observations on Death from Starvation.' By Robert Fowler, M.D. Edin. &c. 1871.

week of watching; and nevertheless, during the first three week of this total abstinence the bowels were not only frequently an largely relieved (possibly of matters collected previously), bu that the usual quantity of water was passed for several week that the hair which had fallen off grew again, thick and long that her naturally healthy look was more than maintained, an her bulk apparently increased.

It was at the period to which we are referring (October, 1867) that visits of curiosity commenced, and soon became common, followed by their natural consequences—presents of money and books, mostly religious. The girl was gaily and fantastically dressed, and got up for show, somewhat after the fashion of a bride. By the end of the year 1868, the case became so notorious that visits grew more and more numerous, railway and local guides coming into requisition. A local reporter an several medical visitors now appear on the stage. In the sprin of 1869, a public meeting was held, and a watching committe appointed whose inefficiency and failure are duly reported p. 22 of Dr. Fowler's work. Other visits of inquiring and inte ligent persons followed, and on the 7th September, 1869, D Fowler wrote a letter to the 'Times,' giving the results of careful and judicious inquiry carried as far as the parents wou permit, and giving it as his opinion that Sarah Jacob was d ceiving her parents, and that it was not possible to state wl part of the symptoms resulted from "a morbid perversion will," and what from "intentional deceit."

The complete publicity thus given to the case, led, by ste not necessary to describe, to the selection of four trained nur from Guy's Hospital, to visit and keep constant watch ov Sarah Jacob, in order to ascertain whether she got food a drink, or not. Certain medical men were also selected as visito An early result of this procedure was to disprove one of the a sertions made by the parents to the effect that the usual d charges from the bowels and bladder were absent. The histo of the case from day to day is one of gradual loss of strengt development of feverishness, restlessness, and occasional deliriu progressive quickening of the pulse, and the exhalation fro the body and breath of a very peculiar and highly offensive odou In spite of the warnings given to the father, no food or drin was supplied, and on the eighth day the girl died exhausted an insensible.

On the 21st December, 1869, an inquest was held, and ev dence given as to the state of the body after death. It was plum and well formed, and covered with fat from half an inch to a

inch thick; there was no obstruction in any part of the alimentary canal, and all the important organs of the body were sound. The body was perfectly free from disease. The jury brought in a verdict to the effect that Sarah Jacob died from starvation caused by the father's neglecting to induce her to take food. The father was accordingly committed for manslaughter, but admitted to bail. The case was then taken up by the Government, and on the 26th February, 1870, summonses were served on the five medical men who had been in attendance during the watching, and on the parents of the girl; and a ten days' inquiry was held before the bench of magistrates, adjourned, and resumed. The result of the inquiry was the acquittal of the medical men, but the committal for trial at the next assizes of the parents, Evan and Hannah Jacob. On the 13th July, 1870, the grand jury found a true bill, and the following day the trial took place, which issued in a verdict of guilty against both parents, with a recommendation to mercy of the mother.

Sarah Jacob evidently succumbed to the form of starvation that proved fatal to the three who died among the thirteen shipwrecked sailors whose cases are given above, and to those who perished soonest among the eighteen, of whom Captain Casey was the solitary survivor on the 28th day. In these instances death took place under privation and exposure in less than twelve days, and we have now to add the death on the eighth day of a girl twelve and a half years old, apparently healthy, but ill-prepared for total abstinence from food and drink by more than two years spent chiefly in bed, dating from a recovery not complete from a series of maladies, comprising scarlet fever, acute gastric derangement, symptoms attributed to inflammation of the brain, pleurisy, and anomalous rigid spasms of some continuance.

To these quicker deaths, attended by only slight loss of substance, the analogy of medical nomenclature justifies us in applying the term "*Acute Starvation.*" If this term be accepted as descriptive of these cases, and the limit of survivorship be taken at *two weeks,* we shall be justified in characterizing as *chronic starvation* those in which the abstinence from food (complete, or nearly so) has extended to the extreme limit of *two months.* In the first class, the body may be found well nourished; in the last reduced to the extreme described by Dr. Willan as "emaciated to a most astonishing degree," or, in the words of Mr. Biggs, "like a skeleton with the skin tightly stretched over him;" so that "he could not only see each bone but its peculiarities."

PART III.

TOXICOLOGY.

The frequent occurrence of cases of real or supposed poison and the complicated nature of the questions to which they rise, render this not only the most interesting, but the most portant division of Forensic Medicine; while the great numb recognised poisonous agents causes it to occupy no inconside part of every medico-legal treatise.

Before proceeding to treat of the Poisons in detail, ce questions relating to poisons and poisoning in general will ha be discussed, such as the definition of the word poison, the of action of poisons, the causes which modify their actio the classification of which they are susceptible.

It will also be necessary to point out the means we poss answering the many questions which present themselves for tion when a suspicion of poisoning has been raised, and w required to determine whether it is well or ill founded. U this head we shall have to discuss the inferences that ma drawn from the origin and progress of the symptoms which rise to the suspicion; the value and significance of post-mo appearances when death happens; and the light that ma thrown upon the case by experiments on animals, by che analysis, and by the conduct of suspected persons.

Again, the precautions which ought to be observed in con ing post-mortem examinations in cases of suspected poiso and those equally important which should be borne in mi the several steps of a chemical investigation, ought to be carefully examined and explained.

These leading divisions of the subject of poisoning wil treated, with some detail, in three separate chapters, bein many departments of the principal subject of Poisons General.

CHAPTER I.

DEFINITION OF A POISON: ACTION AND CLASSIFICATION OF POISONS.

1. *Definition of a Poison.*—The *meaning* which ought to tach to the word poison is best ascertained by a simple process exclusion. A substance that affects one person through pecu- rity of constitution, but has no effect on others, is not a son: a substance which owes its effect to some temporary con- ion of system, as when cold water is swallowed by a person ted by exercise, is not a poison: substances which mechanically ure and inflame the internal parts, such as pins and needles, l particles of steel or glass, are not poisons: again, hot water, water being merely a vehicle for heat, is not a poison. Sub- nces, therefore, which owe their action to some peculiarity of stitution, or unusual condition of the body; mechanical irri- ts; and harmless substances rendered injurious by extraneous ses, are not properly termed poisons. Nor does the mode of lication form any part of the definition of the word. Whether lied to the skin, or inhaled, or swallowed, or introduced into anus or vagina, ear, or nostril, it is still a poison. Again, quantity that may prove fatal, or the time required to destroy e, cannot enter into the definition; nor can the form of the bstance or matter, whether solid, liquid, or gaseous, be held be material. These exclusions have narrowed the possible finition of a poison, so that the following may be accepted as fficient for every practical purpose:—A poison is any substance matter (solid, liquid, or gaseous) which, when applied to the dy outwardly, or in any way introduced into it, without acting echanically, but by its own inherent qualities, can destroy life.

In the great majority of cases poisons are swallowed. They re "*given to*," "*administered to*," or "*taken by*" the person in- ured or killed; but they have been introduced into the body hrough the lungs, rectum, vagina, ear, or nostril. They have lso been applied by subcutaneous injection, or to the skin un- broken or abraded.

The word "poison" is often qualified by such terms as "active,"

"virulent," "deadly," and the last of these terms is very generally used in indictments.

A "deadly" poison may mean one that is fatal in a small dose or kills quickly in a larger one, or which, irrespective of the dose, is more dangerous or difficult to counteract than others. Strychnia and oxalic acid, for instance, are both "deadly poisons;" but while less than a grain of the one and less than half an ounce of the other may destroy life, a full dose of oxalic acid may kill much more quickly than even a large dose of strychnia. On the other hand, the fatal dose of Epsom salts or sulphate of potash is two or three ounces, and even those quantities would not prove certainly or rapidly fatal; so that it would be incorrect to call these substances "deadly poisons." Nor would the term be rightly applied to such a substance as sulphate of zinc, which is often prescribed as an emetic in doses of a scruple or half a drachm; or to the non-corrosive preparations of mercury, iron, or copper. In any case the term "deadly poison" is open to the objection of raising an unnecessary verbal question; and when used in indictments should be treated as mere "legal surplusage," in accordance with the wise dictum of Mr. Justice Erle.

"A destructive thing," a phrase also used in indictments, if not a poison properly so called, must be some substance, or matter, which kills by a mechanical action on the internal parts or by some adventitious property, such as heat. Particles of glass or steel, by irritating the lining membrane of the alimentary canal; pins and needles, by wounding vital organs, or inflaming less important parts, and hot water by causing fatal inflammation, may be fairly regarded as "destructive things;" but it is doubtful whether the term would apply to such matters as sponge, or plaster of Paris, which may destroy life by blocking the passage of the intestines.*

Having defined the term "poison" with sufficient precision to indicate the matters which will have to be examined in the following pages, certain general questions relating to poisons must

* It would appear from a recent decision (Court for Crown Cases Reserved —Queen *v.* Cramp. 'Times,' March 1, 1880), that the element of quantity must be taken into consideration in the legal definition of a "noxious thing." The prisoner was indicted for having administered a "noxious thing"—half an ounce of oil of juniper, with intent to cause abortion. He was convicted; but an appeal was lodged on the ground that the thing must be noxious in itself, and not merely when administered in excess. Lord Coleridge in pronouncing judgment held that there was no substance deemed poisonous which might not be salutary in certain medicinal doses; that the reasonable construction in every case is a question for the jury whether the substance under the circumstances of its administration is a noxious thing or not. "If a person administers, with intent to procure miscarriage something which as administered is 'noxious,' he administers a 'noxious thing.'"

ext be considered. These are,—*Their mode of action*, and *The uses which modify their action.*

2. *Mode of action of Poisons.*—This is twofold, *local* and *emote.*

Their *local* action may consist in *corrosion*, or chemical decomposition, as when a strong acid, a pure alkali, or a corrosive salt, s applied externally or taken internally: in *inflammation*, followed by adhesion, suppuration, ulceration, or gangrene, when such irritants as arsenic, tartar-emetic, or cantharides are similarly taken or applied: and lastly, in an effect on the nerves of sensation or motion. The numbness and tingling of the lips, tongue, and throat, occasioned by chewing monkshood, the sharp pricking sensation in the tongue caused by the arum maculatum, and the numbness of the skin which ensues on the application of prussic acid, chloroform, or veratria, are instances of local action on the nerves of sensation; while the palsy, due to he direct application of opium, ticunas, or prussic acid to the nuscles, the dilatation of the pupil from the application of belladonna, and its contraction under the use of the Calabar bean, llustrate the same local action on the tissues of the iris.

The *remote* action of poisons is also twofold, *common* and *pecific.* Their *common* effect is that which would result from ny severe injury to the same part; their *specific* effect such as e poison alone can produce. The two effects, or modes of acon, may be noted in the symptoms caused by such a poison as rsenic, which when swallowed, and so applied to the lining memrane of the alimentary canal, gives rise to the same cramps as holera, English and Asiatic: but the same poison, inserted into wound, applied to the skin, or inhaled, inflames the mucous urfaces with which it does not come into immediate contact. This is its specific action. Again, oxalic acid, which acts on the tomach as a corrosive and violent irritant, causes the same contitutional shock which attends all severe local injuries: this is ts remote common effect; but it has also a remote *specific* effect on the heart and nervous system. The purest example of a remote constitutional effect of a common kind is afforded by the mineral acids, and the alkalis and their carbonates, which, by the local destruction they occasion, give rise to the symptoms of collapse present in extensive burns and scalds. This absence of remote specific effects has led some authors to doubt the propriety of classing these chemicals among poisons.

A knowledge of the *specific* remote action of poisons is of the first importance, for it often enables us to define the class to which a poison belongs, and even to indicate the very poison itself.

Thus, stupor points to the action of some member of the narcotic class; delirium to the class which comprises belladonna, hyoscyamus, and stramonium; paralysis, or great loss of muscular power, to the action of hemlock, tobacco, digitalis, aconite, or the Calabar bean; tetanic spasms would lead us to infer the action of strychnia; arsenic sets up inflammation in the mucous membranes; mercury attacks the salivary glands and mouth; cantharides the urinary system; chromate of potash the conjunctiva; iodine the lymphatic glands; phosphorus affects the liver; and spurred rye produces gangrene of the limbs. Poisonous substances used in the arts also reveal themselves through their specific actions. Thus the dropped hand betrays the use of lead, paralysis agitans that of mercury, gangrene of the jaws that of phosphorus, and a peculiar rash about the nostrils, ears, bends of the arms, and scrotum, that of the arsenite of copper.

These statements might lead to serious mistakes if it were not understood that some constant symptoms of these poisons are also occasional symptoms of others. Thus, tetanic spasms, so characteristic of the action of strychnia, may occur in poisoning by morphia and other of the alkaloids, as well as by arsenic, corrosive sublimate, and tartar-emetic. Salivation, again, may result from poisons other than mercury; and the dropped hand from the preparations of arsenic as well as from lead. Nor should it be forgotten that these are but the leading phenomena among a considerable group of less characteristic symptoms. Thus, severe irritation of the alimentary canal, inflammation of all the mucous surfaces, a rapid pulse, a series of acute nervous symptoms, and a cutaneous rash, may all occur in a case of arsenical poisoning; and the same is true of oxalic acid and the salts of mercury. It must also be understood, that many of the best-marked symptoms of poisoning are also symptoms of diseases—a fact that will be fully illustrated in the chapter which treats of the Evidence of Poisoning. (P. 368).

In producing their remote specific effects, poisons must be absorbed and carried with the blood to the parts affected. That poisons are absorbed and circulated through the system, in whatever way the poison is applied or introduced, is proved by the analysis of the blood, secretions, and solid textures; and the list of poisons thus detected includes every substance which can be recognised by its odour or colour, or which (not having been completely decomposed) can be submitted to chemical reagents.

The fact of the absorption of poisons is therefore established and admitted; but the question arises—Is the fatal action of poisons due to their absorption? This question will be answered

ı the affirmative if it can be shown that poisons continue to act › long as the blood passes freely from the point of insertion to ıe tissues or organs affected, and that their action is stopped or ostponed when the circulation is arrested.

Magendie's well-known experiment in which a poisoned limb vas connected with the body only by quills introduced into its large vessels, and yet the poison continued to act, establishes the first proposition as true of wounds; while Mr. Blake's experiment with prussic acid introduced into the stomach through an opening in its walls, the poison producing no effect so long as the vessels passing from the stomach to the liver were secured by ligature, but beginning to act within one minute of its removal,* proves the second proposition to be true of poisons that are swallowed. That the great nervous trunks cannot transmit the poisonous influence, is proved by the facts that poisons inserted nto a limb connected with the body by nerves only, are inactive; nd that division of the spinal marrow does not prevent the action f those poisons which prove fatal by attacking that part.

Poisons then, whether inserted into wounds or introduced into ıe stomach, if absorption be prevented, and the circulation rrested, cease to act. Indeed it is not till the poison enters the rculation that it can be truly said to be introduced into the body, r a poisonous substance taken into the stomach is, until absorbed, much outside the system as if it were applied to the skin.

The question now arises—In what way do poisons, circulating ırough the system, produce their fatal effects? On what tissues nd organs do they act?

It is plain that all poisons do not destroy life in the same way. Some paralyse the heart, others the respiration directly or indiectly; a third class attack the brain; a fourth the spinal marrow; fifth act on nerves and muscles. Morgan and Addison tried to prove that in these several modes of death the fatal effect of the poison was transferred to the organ or tissue affected, through the nerves of the blood-vessels; but Mr. Blake, by an experiment in which blood poisoned with woorara continued to traverse the arteries and veins of the abdominal viscera for several minutes before any effect manifested itself, refutes this hypothesis.

Important additions have been made to our knowledge of the action of poisons, and of the proximate cause of death in poisoning, by M. Claude Bernard. He showed by well-devised experiments on animals that the more active poisons kill by attacking particular tissues or organs—that woorara paralyses the motor nerves; that

* 'Ed. Med. and Surg. Journ.' vol. liii. p. 45.

strychnia attacks the spinal cord, and excites fatal reflex actions; that digitalis, upas antiar, corrowal, and wao, veratria, and several other poisons, act on the muscular tissue throughout the body, and on the heart as a muscle.*

There remains, then, but this explanation of the fatal action of poisons—that they are carried with the blood to the organs or tissues on which they act.

But the necessity of absorption to the action of poisons has been called in question in consequence of the rapidity with which certain poisons, such as prussic acid, prove fatal; but this objection was removed by Blake's ingeniously contrived and carefully-performed experiments. Having provided a delicate measure of the state of the circulation by inserting into the femoral artery of the animal experimented on the hæmadynamometer of Poiseuille, he introduced directly into the vessels various substances previously known to paralyse the heart, and noted the instant of time at which the first effects of the poison showed themselves, and at which the heart ceased to beat. He found that a poison passed from the jugular vein to the lungs of a dog in from four to six seconds; to the coronary arteries of the heart in seven; to the carotid artery in from five to seven; and from the aorta to the capillaries in four seconds. A poison introduced into the jugular vein was distributed through the whole body in nine seconds. In the horse, the circulation was completed in from twelve to twenty seconds, or somewhat less than the twenty-five seconds deduced by Hering of Stuttgardt from his experiment.

These experiments are confirmed by the more recent ones of Claude Bernard. A saturated solution of sulphuretted hydrogen, introduced into the jugular vein of a dog, began to be eliminated from the lungs in three seconds; and when injected into the femoral vein of the same dog, in six seconds.

The time required for the circulation of a poison through the body of a dog being taken at nine seconds, it follows that if poisons applied to the dog's tongue do not act in so short a space of time, absorption may take place, and the blood may be distributed to the organ on which it produces its fatal effects. Now, Blake found that strong hydrocyanic acid applied to the tongue of a dog did not begin to act till eleven seconds, and did not kill till thirty-three seconds; and when a tube was previously introduced into the larynx, so that the vapour of the acid did not enter the lungs, the first symptoms did not show themselves till sixteen seconds, and death did not take place till after the lapse

* Lectures in 'Medical Times and Gazette,' 1860, vol. ii. Nos. 532, 3, and 5.

of forty-five seconds. Nicotine, the essential principle of tobacco, applied to the tongue of the same animal, did not kill till twenty seconds. There is a small group of well-authenticated cases indeed, in which poisons have destroyed life instantaneously, or much more promptly than in any of Blake's experiments. Thus, Christison states that an animal has been killed outright by prussic acid in four seconds; * and cases are cited by the same author, and by Dr. Taylor, † in which the same poison killed in three, and even in two, seconds; and in the experiments of Sir Benjamin Brodie, alcohol and the essential oil of bitter almonds seem to have had the same instantaneous effect. ‡ But though these facts seem difficult to account for by the ordinary rate of absorption, we are warranted in asserting that absorption is necessary in the case of all poisons which do not kill by reflex shock.

A fact reported by Sir B. Brodie renders it probable that poisons may act through continuity of tissue. A man was bitten in the hand by a rattlesnake. Inflammation, sloughing, and suppuration of the cellular tissue of the arm followed, with copious and extensive extravasation of blood beneath the skin of the chest and back, limited to the injured side of the body.

The theory of absorption finds a practical application in the use of ligatures, cupping-glasses, and lip-suction, in the case of poisons inserted into wounds.

3. *The causes which modify the action of poisons* are three in number:—1. *Their quantity and form.* 2. *The part to which they are applied.* 3. *The condition of the body itself.*

1. *Quantity and Form.—Quantity.*—As a general rule, the larger the quantity of a poison the more prompt and severe its action; but a large dose of a poison that is swallowed may be immediately and completely discharged, while a smaller dose may be retained and prove fatal. The action of some poisons also varies remarkably in kind as well as degree with the quantity taken. Thus, a large dose of oxalic acid may kill almost instantly by shock; a smaller dose may still prove fatal by acting on the heart; a yet smaller dose affects chiefly the spinal cord; and a more minute dose still, the brain. Again, small repeated doses will develope other symptoms than a single large dose. Of the whole class of narcotico-acrid poisons, it may be affirmed, that in large doses they act chiefly on the nervous system, in smaller doses on the alimentary canal.

* 'Treatise on Poisons,' p. 7.
† 'Medical Jurisprudence,' 5th edition, p. 160.
‡ 'Physiological Researches,' p. 139.

Form.—Under this head will have to be considered—*a. State of Aggregation. b. Chemical Combination. c. Mixture.*

a. State of Aggregation.—Solution increases the activity of poisons, both by promoting absorption and by applying them to a larger surface. Soluble poisons, therefore, are the most active, soluble salts more active than their less soluble bases, and volatile poisons act with great energy on the lungs and skin.

b. Chemical combination.—Such poisons as the mineral acids and the alkalis lose their active properties when neutralized; and, as a rule, the salt resulting from the union of acid and base is more or less active as it is more or less soluble. Acid poisons in combining with bases, or basic poisons combining with acids, conform to the same rule, and the resulting compounds, if soluble, retain the specific characters of their active ingredient. Thus, all the soluble salts of morphia have the same action; and the same is true of all the soluble compounds of oxalic acid. When two poisonous substances combine (as arsenious acid with copper, or prussic acid with mercury or silver), the resulting compound may give rise to the symptoms of the more active, to the mixed effects of the two, or to symptoms peculiar to itself. Lastly, some poisons insoluble in water, as arsenite of copper, and carbonate of lead or baryta, may be rendered soluble and active by the acid juices of the stomach, or by the secretions of the skin.

c. Mixture.—All admixtures which render a poison more soluble make it more active; all others have a contrary effect. Thus, acids increase the activity of opium, and of the salts of copper, and water of arsenic; but oily, mucilaginous, albuminous, and starchy liquids retard the action of poisons by protecting the coats of the stomach, by involving the poison, if in substance or powder, or even by acting as antidotes. Hence the frequent escape of those who have taken large doses of arsenic or corrosive sublimate with, or directly after food. Much also depends on the character of the food. Thus, arsenic in a solid dumpling would act much more slowly than in porridge, and in porridge than in liquids in common use; and strychnia in a pill more slowly than in a mixture. We avail ourselves of the protective effect of thick liquids in the treatment of cases of poisoning, and we give substances that have little power as antidotes, because they have the property of withdrawing and holding in suspension certain poisons. Powdered charcoal is the best example of this class; and magnesia and the sesquioxide of iron owe their repute, as antidotes to arsenic, chiefly to this property.

2. *Part to which the Poison is applied.*—The effect of a poison on different parts of the body is directly as their absorb-

ing power. Thus, poisons act most promptly when inserted into a wound; the serous surfaces hold the next place; then the stomach; then the unbroken skin. Injection into a vein insures the quickest action; but volatile poisons introduced into the lungs act nearly as promptly. The effect of the corrosive poisons and stronger irritants is proportioned to the importance of the part to which they are applied. Thus, the mineral acids prove speedily fatal when they attack the windpipe; less speedily when they act on the gullet and stomach, and they must destroy a large surface of the skin in order to kill quickly. Many animal poisons, such as those of the viper or mad dog, and also curara, introduced into the system in a minute quantity by cutaneous puncture, kill very quickly, though the same quantity, and even a much larger dose, may be swallowed with impunity.

This remarkable fact can now be physiologically explained. A certain quantity of the poison must be present in the circulation before it can manifest its effects; and if the excretion is as active as the absorption, no effect is produced. The poison curara, is got rid of by the excretory organs as quickly as it is absorbed from the stomach. But if the excretion of urine is prevented by ligature of the renal artery, the introduction of the poison into the stomach develops its symptoms just as certainly as if it were conveyed into the circulation by a wound.

3. *Condition of the Body itself.*—Under this head will have to be considered—*a. Habit. b. Idiosyncrasy. c. Disease. d. Sleep.*

a. Habit.—No broad general rule can be laid down as to the influence of habit. Such vegetable poisons as opium, alcohol, and tobacco, lose their effect by repetition, and may at length be taken in doses which would poison one unaccustomed to their use; but even these poisons produce permanently injurious effects, alcohol causing disease of the lungs, liver, kidneys, and brain; tobacco quickening the pulse; and opium injuring the digestion, emaciating the body, and enfeebling the mind. The less deadly mineral poisons, such as the sulphates of zinc, iron, and copper, may, however, be taken by healthy persons in continually increasing doses; even arsenic is so taken by the Styrian peasants; but arsenic, mercury, and phosphorus, when used in the arts, and gradually introduced into the system, appear, like the carbonate of lead, to be more dangerous the longer they are used. Nor do men and women who work with arsenite of copper grow more tolerant of the poison. The same effects are reproduced at each resumption of their employment.

b. Idiosyncrasy.—Under this term are included certain peculiarities of constitution, of which some may be explained by the

relation between the two processes of absorption and excretion; while others cannot be satisfactorily accounted for. Idiosyncrasy may show itself in two ways—1. By difference of susceptibility without difference of action. Thus, a few grains of mercury shall salivate one man, but as many drachms or ounces shall not affect another. 2. By exceptional action; as when Epsom salts act like opium, and opium has a purgative effect; and a simple article of diet, certain kinds of meat, even mutton itself, fish, fruit, and vegetables, prove poisons to a few individuals.

c. Disease.—This, as a rule, renders the body less susceptible. Thus, patients reduced to extreme weakness by fever, are scarcely affected by stimulants which would overpower the strong. In continued and yellow fever there is great tolerance of mercury, but in paralytic affections and anæmic states, an opposite condition; in anæmia, large doses of steel are readily borne; and in severe dysentery, cholera, and hæmorrhage, large quantities of opium; in severe affections of the nervous system, all remedies, but especially narcotics, may be given in greatly increased doses. Delirium tremens may be safely and successfully treated by half-ounce doses of tincture of digitalis, and one form of mania by repeated doses of two scruples of opium. Poisons which give rise to symptoms similar to those actually existing, form an exception to the rule. Thus, the irritants would increase gastritis, diarrhœa, or dysentery; and the narcotics exasperate a determination of blood to the brain, or an attack of uræmia.

d. Sleep.—In this state all the functions are languid, and the body less alive to the action of medicines and poisons. This is true of sleep artificially induced; hence narcotics given with or before other poisons, weaken or counteract their effects. Opium, for example, when given with arsenic, not only masks the symptoms proper to that poison, but appears to retard its operation.

4. *Classification of Poisons.*—Two principles of classification commend themselves as logical and useful. The one arranges poisons according to their source, the other to their action. When the first is adopted, poisons are arranged as inorganic and organic; or as mineral, vegetable, and animal; when the second, they are grouped also in three classes—irritants, narcotics, and narcotico-irritants. To the first classification it may be objected that though most poisons from the mineral and animal kingdoms are irritants, those from the vegetable kingdom comprise, in addition to irritants, several poisons which, under any arrangement, must be distributed into many groups. On the other hand, a classification based on mode of action has the inconvenience of separating poisons which, being derived from the

same kingdom of Nature, present analogies of chemical composition that render their juxtaposition extremely convenient.

By no possible classification, then, can we reconcile the conflicting requirements of physiology and natural history, or attain the highest scientific accuracy. But those who see in classification rather an instrument of convenience than an expression of abstract truth, will acquiesce in any grouping which brings into contact those objects that are best studied when they precede or follow each other, and concerning which, when so placed, certain general principles can be laid down.

Foderé's division into *irritants, narcotics, narcotico-acrids,* and *septics,* rests on a physiological basis, as does also that which excludes the last, and retains the other three. But the best toxicologists have grown dissatisfied with the third group of narcotico-acrids, and have tried to construct a classification on the same basis. The most ambitious, but least successful, attempt, is that of Tardieu; that of Casper is scarcely an improvement: that of Dr. Taylor is less open to objection.* After examining these schemes, and the juxtapositions to which they give rise, we prefer a compromise between the claims of physiology and natural history. We first divide poisons into *inorganic* and *organic,* and then distribute them into sub-classes: the inorganic into *corrosives* and *irritants;* the organic into *irritants,* and such as affect the *brain, spinal cord, heart,* and *lungs* respectively: The intestinal irritation which marks the action of so many organic poisons, and justifies the use of the term *narcotico-acrid,* will be considered as subordinate to their effect on the nervous centres, heart, and lungs. The classification, as far as it is necessary to explain it here, will therefore be as follows:—

1. Inorganic.	*a.* Corrosive. *b.* Irritant.	2. Organic.	*a.* Irritant. *b.* Affecting the brain; spinal cord; heart; or lungs.

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* Irritants et corrosifs. 2. Hyposthénisants. 3. Stupefiants. 4. Narcotiques. 5. Nevrosthéniques (Tardieu). 1. Irritant poisons. 2. Poisons which produce hyperæmia. 3. Nerve-paralysing poisons. 4. Poisons which produce marasmus. 5. Septic poisons (Casper). 1. Irritants. 2. Neurotics, distinguished as cerebral, spinal, and cerebro-spinal (Taylor).

CHAPTER II.

EVIDENCE OF POISONING.

AMONG the circumstances which would lead us to infer that so[me] poison had been taken, are the *Symptoms, the post-mortem a[p]pearances; experiments on animals; chemical analysis; a[nd] conduct of suspected persons.*

1. *Symptoms.*—In most cases of poisoning the symptoms ap[-]pear suddenly, in a person in good health, soon after taking foo[d,] drink, or medicine; and in most fatal cases, death happens in [a] few minutes, hours, or days.

The sudden appearance of the symptoms affords a presumptio[n] in favour of poisoning; for, in full doses, poisons act promptl[y.] On the other hand, when given in small and repeated doses, t[he] symptoms may develop themselves gradually. But many diseas[es] of the vital organs—brain, heart, and lungs—perforation of t[he] stomach or intestines, and severe epidemic maladies, such [as] plague, cholera, yellow fever, continued fever, the febrile exa[n]themata, small-pox, scarlatina, and measles, set in suddenly wi[th] severe and well-marked symptoms.

The occurrence of the symptoms in a person in good heal[th] also affords a presumption of poisoning; but as many acu[te] diseases suddenly attack healthy persons, and many sudden deat[hs] occur in others seemingly in rude health, too much stress mu[st] not be laid on this sign. It should also be borne in mind th[at] poisons are sometimes given to the sick, and that after the heal[th] has been slowly undermined by repeated doses of some less acti[ve] substance, such as tartar-emetic, death has been suddenly broug[ht] about by such deadly poisons as morphia, strychnia, or veratri[a.] Witness the French case of Castaign, and the English cases [of] Palmer, Dove, and Pritchard.

The appearance of the symptoms soon after taking food, drin[k,] or medicine, affords a stronger presumption; for large doses o[f] the more active poisons act very quickly. But it must be recol[-]lected that vomiting and other symptoms of indisposition ma[y] set in after a wholesome meal; that a full meal is a common pre[-]cursor of apoplexy; that rupture of the coats of the stomach, softened by previous disease, naturally takes place while the

organ is distended with food; that English cholera may be caus by unripe fruits, putrid meat, or other unwholesome ingesta; and that a large draught of cold water swallowed while the body is heated, may cause instant death.

The presumption afforded by the symptoms occurring soon after a meal is greatly strengthened when other persons partaking of the same meal are similarly affected: but too much importance should not be attached to the absence of such effects in others; for the person in whom the symptoms have shown themselves may have partaken of some dish, or part of a dish, or of some wine or drink, which the others had not tasted.

The attack of several persons by similar severe symptoms, soon after a meal of which all have partaken, affords the strongest possible presumption of poisoning either by the food itself, or by some accidental or intentional admixture.* If the symptoms are those of simple irritant poisoning, we cannot determine by the symptoms alone which of these alternatives is the true one; but they may be so characteristic as not only to prove the administration of a poison, but to indicate the very poison itself.

The simultaneous fatal attack of several persons in the same place, or on the same mission, in the absence of proof that they had partaken of the same food, would also furnish a strong presumption of poisoning. Thus, the death in one night of four of the eight peers selected to represent the Scottish nation at the nuptials of Queen Mary with the Dauphin of France, in 1558 (Lord Fleming at Paris, Bishop Reid, the Earl of Rothes, and the Earl of Cassilis at Dieppe), certainly justified the suspicion of oisoning, for which the refusal of the Scottish deputies to grant he crown matrimonial to the bridegroom had furnished a motive y giving great offence to the French Court.†

A suspicion of poisoning is often successfully rebutted by the act that no food, drink, or medicine had been taken for hours efore the commencement of an illness attributed to a quickly cting poison. The inference would be somewhat weakened if leep had occurred in the interval.

* When the jail-fever prevailed in England, it was not unusual to attribute o the food of which a group of persons had partaken the fatal consequences eally due to the poison of the prison. In a curious case, which occurred at edhill, more than a century ago, certain Justices of the Peace all partook f the same meal, and were soon taken dangerously ill. This was, at first, ttributed to the meal; but the true cause (the wretched condition of a atch of paupers brought from the workhouse) was inferred from the fact hat the only member of the group who had escaped, was one who had not een brought face to face with these paupers. The symptoms, as they eveloped themselves, confirmed the inference drawn from this exceptional ccurrence.

† Sharp's 'Peerage'—Marquis of Ailsa.

The rapid course of the symptoms towards a fatal termination affords but a weak presumption of poisoning; for many cases of poisoning end fatally after a considerable interval, and many acute diseases run a very quick course.

All the characters now mentioned are, therefore, to be received with caution, and carefully weighed. The joint occurrence of two or more of them would afford a strong presumption; and the coincidence of all, though not decisive, would justify a very strong suspicion. Thus, if a person in perfect health, soon after taking food, were attacked with severe and continued vomiting and purging, and died within twenty-four hours, a strong suspicion would naturally arise that the food had contained some poisonous substance; and the suspicion would be greatly strengthened if other persons who had partaken of the same food were similarly affected. The food itself might have had poisonous properties or the poison might have been added to it; but the probability of poisoning in one of these two ways is very strong; and the inference would be almost irresistible if it could be shown that the person affected had never suffered in the same way before, and that neither English nor Asiatic cholera prevailed at the time.

2. *Post-mortem Appearances.*—There are certain poisons and classes of poisons which leave in the dead body unmistakable signs of their action. Mineral acids stain and corrode the parts with which they come in contact, and oxalic acid in strong solution destroys and blackens the lining membrane of the gullet and stomach. Other poisons yield highly characteristic deposits. Corrosive sublimate, decomposed by the secretions and membrane of the stomach, or by its albuminous contents, leaves a slate coloured deposit of finely-divided mercury; and arsenious acid in substance a white patch clinging to the inflamed membrane which may be changed into the yellow sulphide by sulphuretted hydrogen, the product of putrefaction. Orpiment and Scheele's green, cantharides, and nux vomica, and the spores of poisonous mushrooms, also leave a coating of characteristic colour; phosphorus betrays itself by shining in the dark; and vegetable poisons are sometimes identified by seeds, or fragments of leaves left in the alimentary canal.

Other poisons, again, whether inorganic or organic, both those which have a simple irritant action, and those formerly classed as narcotico-acrids, excite a more intense inflammation in the stomach and intestines than that due to disease. A less degree of redness being common in those who die a natural death, would not justify a suspicion of poisoning; and the same remark applies to those appearances of congestion in the brain which are commo

to the action of the narcotics and narcotico-acrids, and to many cerebral diseases and disorders.

Great importance naturally attaches to the negative evidence from post-mortem appearances; such as the absence of corrosion in alleged cases of poisoning by corrosives, and of inflammation, after the alleged administration of an irritant or narcotico-irritant poison. The absence of congestion of the brain, in a case of imputed narcotic poisoning, would afford a lower presumption.

The absence of characteristic post-mortem appearances might also become important in the very inprobable event of poison being introduced into the body after death, with a view to inculpate an innocent person.

Formerly undue importance was attached to the unusual blackness or lividity of the skin, and to the early occurrence of putrefaction as evidence of poisoning. But there is no reason to believe that these appearances are more common after death by poison than after other forms of sudden or speedy death; and it is now well known that some of the mineral poisons—for instance, arsenious acid, corrosive sublimate, and chloride of zinc—preserve the parts with which they come in contact.

Post-mortem appearances similar to those produced by poison, even though confirmed by the discovery of the poison itself, would not prove that death had been caused by poison; for it might be due to some cause anticipating its fatal action. On the other hand, a dead body may bear marks of severe external injury, or extensive disease of the internal organs, and yet the real cause of death be poison.

Post-mortem appearances, then, though they furnish conclusive independent evidence in the case of several poisons, afford only a presumption in a larger number; but even when inconclusive in themselves, they may strengthen, by their presence, the presumption drawn from symptoms, or from moral evidence; or, by their absence, invalidate a charge prompted by malice.

3. *Experiments on Animals.*—These are very valuable both as affording evidence of poisoning, and as illustrating the mode of operation of poisons. Experiments, confirmed by happy accidents (as when domestic animals and poultry have partaken of the same food as the poisoned person, or have eaten the matters ejected from his stomach), have shown that the dog and cat, as well as poultry, are killed by the poisons which prove fatal to man, and that they die with symptoms similar to those by which he suffers; and when, as in poisoning by prussic acid and strychnia, the effects of the poison are quickly developed with symptoms of a very marked character, the evidence from

this source must be admitted to be conclusive. But even in the absence of any previous experience of the effect of poison on a healthy living creature, its death soon after the administration of a poison which is believed to have proved fatal to a man, affords the strongest evidence in favour of his having been poisoned, even without taking into account the character of the symptoms. On the other hand, should the animal neither suffer nor die, the presumption in favour of the harmlessness of the substance under trial is very strong. When the substance supposed to contain poison is so abundant that it can be given to different animals, or when the matters rejected from the stomach happen to be eaten by them, the death of all the animals affords undoubted proof of poisoning.

In rare cases of poisoning of animals by arsenic or strychnia, good evidence has been afforded by the fatal effect on other animals of eating their flesh.

The value of the evidence from experiments on animals is affected by certain considerations arising out of the discrepant effects of the same poison on different living creatures. It has been ascertained beyond all doubt, that there is at least one insect that can feed and flourish on strychnia; and nearly half a century ago M. Runge, of Berlin, fed a rabbit exclusively for no less than eight days on the leaves of belladonna, hyoscyamus, and stramo nium, and though he found that the poisonous principles had been taken up into the animal's body, the animal at the end of the time was as healthy as at the beginning; there was no even any dilatation of the pupil. Dr. W. Ogle, in a lette addressed to the *Times* in August, 1865, applies this fact to th case of Mr. Sprague, tried for attempting to poison the Chalk family, and acquitted; and deems it probable that the belladonn found its way into the poisoned pie through the flesh of a rabb which had fed on the plant. This explanation must be admitte to be feasible; for it has been well ascertained that poisono plants which prove harmless to insects, birds, and anima that use or consume them, may impart to their secretions an flesh properties highly poisonous to human beings. Thus the honey of bees collected from the calmia azalea and rho dodendron, and even the mead made from them, has bee found poisonous. During the famous retreat of the 10,000 unde Xenophon, the army suffered severely by eating the honey co lected from the azalea pontica. The milk, as well as the flesh, cattle browsing on some of the herbage in South America ha proved poisonous; as has the flesh of hares that had eaten th rhododendron chrysanthemum, that of pheasants that had fed c

the buds and shoots of the calmia latifolia, and that of partridges that had partaken of certain berries during the Canadian winter, and had been imported into this country packed in ice; and as lately as September, 1862, Mr. F. Taylor, of Romsey, reported two cases of great severity from eating the Canadian partridge, and the case of a cat sickened and paralysed by the same cause. Some time since, several persons near Toulouse were poisoned by a dish of snails fattened on the leaves and shoots of coriaria myrtifolia.*

It may be safely conceded, therefore, that certain poisons belonging to the vegetable kingdom may be consumed with impunity by insects, birds, and mammals, and yet the honey collected by bees, the flesh of birds, and the milk and flesh of animals, if consumed by human beings, may occasion distinct, dangerous, and even fatal, symptoms of poisoning.

To the evidence drawn from experiments on animals with matters rejected from the human stomach, or collected from the stomach and intestines after death, it has been objected that the animal secretions may be so vitiated as themselves to prove poisonous, and the objection has been enforced by a well-known experiment of Morgagni. The bile from the stomach of a child, who died in convulsions from tertian ague, mixed with bread and given to a cock, caused convulsions and death in a few minutes, and the same effect followed in two pigeons inoculated with it. But it is obvious that experiments with the bile of a diseased subject can have no proper application to cases in which food rejected from a healthy stomach has proved poisonous to animals.

It is scarcely necessary to state that the negative result of experiments with substances rejected from the stomach, or found there after death, is not conclusive against poisoning, for the poisonous substance may have been evaporated, decomposed, absorbed, or previously rejected.

When there is reason to believe that we are dealing with a small quantity of poison, small animals, such as rats or mice, should be chosen for experiment; or the frog, as particularly adapted for experiment with minute quantities of such poisons as strychnia. Leeches have also been suggested as applicable to the same purpose. The hypodermic method of administering such active medicines as morphia and conia will evidently admit of extension to the identification of poisonous substances, as soon as sufficient data have been collected by well-devised experiments.†

* 'Med. Times and Gaz.' Sept. 13, 1862.

† Dr. John Harley's Gulstonian lectures given at the College of Physicians (1868).

The necessity of experiments on animals is now largely superseded by chemical analysis; but as the tests for some of the vegetable poisons are uncertain, such experiments, performed with care, are valuable, and have been admitted as evidence.*

When experiments on animals are resorted to, in order to illustrate the mode of operation of poisons, or to determine some important question, such as the shortest time within which a dose of prussic acid may prove fatal, or the possible absence of marks of inflammation in the stomach after poisoning by some irritant such as corrosive sublimate, choice should be made of the dog, as the animal of which we have the largest experience.

4. *Chemical Analysis.*—This form of evidence, though not absolutely necessary when the symptoms, post-mortem appearances, and circumstantial evidence confirm each other, or even when two of the three coincide, is always of the first importance. The poison may be discovered in the living person by tests applied to the urine, to the blood abstracted by bleeding, cupping, or leeches, or to the serum of a blistered surface ; or it may be detected in the dead body in the blood, flesh, viscera, and secretions. In either case the discovery of a poison affords conclusive evidence of its administration.

When we are dealing with substances rejected from the stomach or voided by the bowels, with the contents of the stomach and bowels after death, or with food or medicine of which the sufferer has partaken, the evidence is obviously less conclusive, for objections may be raised on each of the three suppositions, that poison is detected, that it is not detected, or that it is found in very small quantity.

When a poison *is found* in the matters discharged during life, or left in the alimentary canal after death, or in food or medicine, it may be objected that it might have been accidentally mixed with it, or fraudulently, in order to inculpate an innocent party; in which case the evidence must be supported by proof that this could not have happened.

But when a poison *is not found* in any of the substances submitted to analysis, it does not follow that none has been taken ; for, in the case of a meal actually containing poison, and followed by symptoms of poisoning, the articles submitted to analysis may not contain the poison, though some other portion of the meal may. The poison may even be so unequally distributed through a single dish that the part examined may not contain it, though

* By the 'Cruelty to Animals Act,' 1876, any Judge of the Superior Courts is empowered to grant a license for such experiments if he should think them desirable in a criminal case.

other parts of it do. The poison may be in the gravy, and not in the meat, or it may have been sprinkled only on the outside of the joint. Again, we may fail to detect poison in the contents of the stomach and intestines, because it had been rejected, or evacuated, absorbed, decomposed, or evaporated; or because it belongs to that large class of vegetable poisons which we have not yet found the means of discovering with certainty. Poisons are most likely to be rejected or evacuated when they belong to the class of irritants, absorbed when they are in a fluid state or soluble, decomposed when they belong to the animal or vegetable kingdom. Poisons which are insoluble, or sparingly soluble, such as arsenic, may often be detected in the stomach, and sometimes in the intestines, after repeated vomiting and purging, being glued to the mucous coat by the tenacious products of inflammation.

When the examination of the body is delayed, and in cases of disinterment, we may fail to discover a poison which was in the body at the time of death, from its having exuded through the textures, evaporated, or been decomposed. This observation does not apply to mineral poisons; for though subject to change by the decay of the textures, they are transformed, not destroyed. Thus, arsenious acid may be converted into the yellow sulphide; and corrosive sublimate may be changed into the black sulphide of mercury, or to calomel, by contact with the mucous membrane, or it may deposit finely divided mercury. Among animal poisons, cantharides, and, among vegetable poisons, strychnia, may be mentioned as undergoing little or no change from the decay of the textures.

It is scarcely necessary to add, that malicious or mistaken imputations of poisoning may be shown to be unfounded by the non-discovery of poison in the matters alleged to contain it.

When poison is found *in very small quantity*, the objection is sure to be advanced that it was not enough to account for death; but to this the reply is obvious that the quantity found must needs fall short of that actually taken: for it is always only a part of the matter vomited or otherwise expelled from the body, of the contents of the alimentary canal after death or of the blood, tissues, or viscera of the body, which is submitted to analysis; and that the quantity found in the stomach is only the surplus of what may have been sufficient to cause death by absorption. The discovery, therefore, of a quantity of poison insufficient to destroy life, is scarcely even a presumption that the substance was not administered in a poisonous dose; though it is consistent with the supposition that it had been given as a medicine.

But the value of chemical analysis as evidence of poisoning, is

not limited to the discovery of a poison by a single analysis; for by comparing one analysis with another, important light may be thrown on the mode of administration, and the innocence or guilt of a suspected or accused party. A bowl of porridge eaten at breakfast by a female believed to have died poisoned, was found to contain arsenic. The chemical analysis showed that the poison was not mixed with the store of meal, but only with the part used in making the porridge; and as other circumstances justified the inference that the poison had been mixed with the meal in the morning before any stranger entered the house, the husband (the only other inmate) was convicted of the murder. In a case of an opposite kind, arsenic was found mixed with a large mass of flour, as well as with the part used in making bread. It was accordingly inferred that the flour had been ground from wheat intended for seed, mixed with arsenic to destroy insects, and sent, in mistake, to the mill.*

In several cases of poisoning by corrosive acids, the clothes of the suspected murderer have been stained in the same way as the clothes and body of his victim.

The cases just referred to are examples of *qualitative* analysis. The value which may sometimes attach to *quantitative* analysis is shown by the two cases which follow.

Mr Hodgson, a surgeon, was tried at Durham in 1824, for attempting to poison his wife. He had substituted corrosive sublimate for calomel in opium pills, prescribed by her physician, but this he said, was a mistake committed while he was intoxicated. It was also proved to have been contained in a laudanum draught, ordered by her physician; but this, too, as he alleged, was an injection of corrosive sublimate previously prepared for a sailor but which he had taken for a water-bottle. But on submitting the draught and the injection to chemical analysis, the former was found to contain fourteen grains, while the latter contained only five grains to the ounce.†

Samuel Whalley was indicted at York Spring Assizes, in 1821, for administering arsenic to Martha King, pregnant by him. But of the tarts in which the arsenic was alleged to have been administered, the portions eaten could not have contained more than ten grains, while the matters alleged to have been vomited, contained, even after repeated vomiting, fifteen grains.

5. *Conduct of Suspected Persons.*—Great importance is very properly attached, in trials for poisoning, to the conduct of the

* Cases quoted from Alison and Barruel, by Christison. 'On Poisons,' p. 75.

† For a full report of this interesting case, see the 'Edin. Med. and Surg. Journal,' vol. xxii. p. 438.

prisoner, before, during, and after the illness of the deceased. He is often proved, without adequate motive, to have made a study of poisons and their properties, and to have purchased them under false pretences; to have compounded medicine, or prepared food for the deceased; to have sought opportunities of administering them; to have made himself the sole attendant on the deceased; to have kept near relatives, and other inconvenient witnesses at a distance; to have placed obstacles in the way of obtaining proper medical assistance; to have made hurried arrangements for the funeral; to have opposed the examination of the body; to have hastily disposed of matters which might have been examined; to have tampered with the matters reserved for analysis. Such acts as these, some of which are likely to fall under the notice of a medical attendant, will have to be carefully weighed by the jury, together with such other items of general or circumstantial evidence as point to the existence of an obvious motive or inducement to the crime, or indicate the previous state of mind of the deceased, as affording a probability, or the reverse of suicide.

6. *Symptoms and Post-mortem Appearances proper to the different Classes of Poisons.*—The foregoing observations will be understood to apply to poisons in general. The symptoms and post-mortem appearances proper to the principal classes of poisons will now be described, both as giving completeness to the present chapter, and as supplying information applicable to the special poisons both of the inorganic and organic divisions. There are two classes of poisons which present both symptoms and post-mortem appearances of a well-defined character—the corrosives and the irritants—and a third class, divided into important sub-classes, according as they affect the brain, the spinal cord, the heart, or the lungs, in which the symptoms are well marked, but the post-mortem appearances less constant, the alimentary canal being subject to like uncertainty of action and post-mortem appearance. This third class formerly comprised the two distinct divisions of narcotics and narcotico-acrids.

a. Corrosives.—This class of poisons is characterized, as the name implies, by their destructive action on the parts with which they come in contact. If they were to act on a large extent of the cutaneous surface, they would destroy life as burns and scalds of like extent and severity. When swallowed, they prove fatal by the same destructive action on the lining membrane of the alimentary canal, or of the windpipe, the immediate causes of death being shock, exhaustion, perforation of the stomach or intestines, starvation from stricture of the gullet, or extensive destruction of the secreting membrane of the stomach, and in rare cases

occurring chiefly in young children, suffocation from injury to the glottis and windpipe. These effects are produced, among inorganic poisons, by the mineral acids and the caustic alkalies and their carbonates, among the organic poisons by strong solutions of oxalic acid, and of tartaric and citric acids. In the group of inorganic poisons there are also several corrosive soluble salts (chlorides) of the metals mercury, antimony, zinc, and tin, which combine with their direct corrosive action remote specific effects in addition to those due to corrosion itself.

The *symptoms* due to these poisons are well marked. They have a strong acid, alkaline, or metallic taste, and cause a burning pain, which occurs almost simultaneously in the mouth, throat, gullet, and stomach, whence it extends rapidly to the entire abdomen. This is soon followed by vomiting, and after no long interval by purging. The matters discharged contain blood, either pure, or acted on by the poison. The epiglottis and upper part of the windpipe are often so corroded as to occasion suffocation and speedy death.

The *post-mortem appearances* are those of corrosion, mixed with corrugation from strong contraction of the muscular fibres, and followed by inflammation and its consequences. The corrosions may be confined to small spots, or may extend over a large surface ; may be limited to a removal of portions, more or less considerable, of the lining membrane of the gullet and stomach, or may destroy all their coats, so as to occasion perforations large or small, and the discharge of considerable portions of the organs themselves (as well as of casts of them resulting from the action of the acids on their secretions) by vomiting or by stool. Beyond the corroded parts, the textures are acutely-inflamed, sometimes gangrenous, often black from blood extravasated into the cellular tissue beneath, or injection of the vessels with dark blood. Sometimes the tissues are found softened, sometimes hardened and shrivelled. These poisons often produce in the gullet a peculiar wrinkled and worm-eaten appearance, due to the contraction of the longitudinal and transverse fibres, and the removal of patches of epithelium. (See figs. 49, 50, and 51, p. 415).

As these effects of the corrosive poisons may possibly be mistaken for post-mortem appearances due to other causes, it may be well to point out more particularly the characters by which the one may be distinguished from the other.

Softening of the mucous membrane due to the corrosives is attended by changes of colour arising, in the case of the mineral acids, from their direct action on the tissues, in the case of corrosive sublimate, from the deposit of the finely divided metal

or its sulphide. In the case of some other corrosive poisons we are not assisted by these changes, but must be guided by the state of the gullet, and the action on the skin and clothes. The *hardened and crimped* state of the parts with which the corrosive comes in contact is eminently characteristic; it is never present in disease. The black injection of the vessels is not conclusive, for it may be produced by the action of any acid liquid or acid secretion of the stomach itself. *Gangrene* is a rare result of disease, and the black infiltration into the submucous tissue for which it is sometimes mistaken is equally uncommon. *Ulceration* and consequent *perforation,* the result of the action of the corrosives, is to be distinguished, in the case of most of them, by characteristic colours; and this is true both of small ulcers and of extensive destruction of the tissues. The characters of ulcers from disease will be presently described, when speaking of irritant poisons. That extensive destruction of the coats that sometimes arises from the action of the gastric juice after death, belongs to this place.

The destructive action of the gastric juice after death was formerly a subject of controversy; but the fact of its sometimes taking place has been placed beyond a doubt, by observations in man and experiments on animals. The usual seat of the opening is the posterior part of the stomach, but it varies with the position of the body. The aperture may be as small as a shilling or as large as the palm of the hand; and it has even been found to occupy one-half of the stomach. It may assume any shape; its edges are fringed, softened, and smeared with a dark pulpy mass; and the vessels of the stomach are often found injected with dark blood—a common action, as already stated, of acid fluids. The neighbouring viscera sometimes undergo a similar change. Occasionally there is more than one aperture. As there is no inflammation around the opening, it is not possible to confound this post-mortem change with the effect of an irritant poison, which would be attended by marks of acute inflammation, and by characteristic stains and deposits. When the gastric juice acts only on the mucous membrane of the stomach, it gives it a soft gelatinous appearance of a black or dark brown colour.

Perforation of the *intestines* is very rare in cases of corrosive poisoning, and perforation of the *gullet* still less common. Both may occur from diseases not difficult to recognise after death.

b. Irritant Poisons.—Substances that inflame the parts to which they are applied are said to act as irritants to those parts; and those which produce the same effect on the alimentary canal are also termed irritants; and, with the exceptions indicated

when defining the term *poison,* of hot and cold water, and such articles as pins, needles, and powdered glass, may claim admission into the list of irritant poisons, if they prove in any instance fatal to life, or produce symptoms of great severity.

The class of irritants comprises mineral, animal, and vegetable substances; it contains a greater number of individual poisons than all the remaining classes put together; and it also contributes largely to the list of cases of poisoning. It accounts for nearly one-fourth of the annual deaths from ascertained poisons; of which the great majority are metallic irritants.

Of this large class, two groups admit of distinction and separation; one, the members of which destroy life by irritating the parts to which they are applied; the other, by adding to local irritation peculiar or specific remote effects. To the first group belong the principal vegetable irritants, some of the alkaline salts used in medicine, the less active metallic poisons, some products of destructive distillation, and the irritant gases. The second group comprises the metallic irritants, arsenic, mercury, antimony, lead, and copper; the metalloidal elements, phosphorus, and iodine; and one product of the animal kingdom, cantharides.

The *symptoms* caused by irritant poisons, as a class, are burning pain and constriction in the throat and gullet; sharp pain, increased by pressure, in the pit of the stomach; intense thirst; nausea and vomiting, followed by pain, tension and tenderness of the entire abdomen; and purging attended with tenesmus, and frequently with dysuria. The constitutional symptoms vary with the intensity of the irritation, and the interval which has elapsed since the administration of the poison, being at one time those of collapse, at another of inflammatory fever. The mode of death also varies. One patient will not rally from the first shock to the nervous system; a second dies in strong convulsions; a third worn out by protracted suffering; a fourth starved through the permanent injury inflicted on the gullet and stomach.

These symptoms vary in severity, and in the time and order of their occurrence, with the quantity of the poison, its solubility, and the full or empty state of the stomach. When the poison is sparingly soluble, as is the case with arsenious acid, the pain and sense of constriction in the throat and gullet are not felt immediately on swallowing it, but after an interval more or less considerable, and, occasionally, they are absent; or they follow the other symptoms instead of preceding them, in consequence of the repeated contact of the dissolved or suspended poison with the upper portions of the tube, in the act of vomiting. The

stronger and more soluble irritant poisons cause the discharges to be mixed with blood, which happens rarely, and to a less extent, in the case of the simple irritants; and they sometimes inflame the upper part of the windpipe, giving rise to hoarseness, wheezing respiration, and harassing cough, occasionally ending in suffocation.

The post-mortem appearances caused by the irritants, are those of inflammation and its consequences.

The simple irritants give rise to inflammation more or less severe, followed by its usual consequences. In some cases there is merely increased vascularity, in others deep redness; and the surface may be coated with a tenacious secretion, and the cavity filled with a glairy mucus. The coats may be found thickened through the intensity of the inflammation; black from bloody extravasation into the submucous tissue; ulcerated, gangrenous, and sloughing; softened; but occasionally hard and shrivelled. Vessels filled with dark blood are sometimes found ramifying minutely over the surface, which in other instances is studded with black points. These appearances are not confined to the stomach, but are found in the fauces, and gullet, and in the duodenum. The rest of the small intestines is often the seat of acute inflammation, with ulceration and softening of the mucous membrane; ulcers are also found in the large intestines, and excoriation of the anus. In some cases the lining membrane of the larynx and air passages is inflamed.

Several of these symptoms and post-mortem appearances are not peculiar to poisoning; they may be present in English and Asiatic cholera, in acute inflammation of the stomach or bowels, in rupture of these parts, or of other viscera of the abdomen. They may also be produced by drinking hot or cold water; and authors have been at some pains to show that simple distension of the stomach, vomiting and purging of blood, colic, strangulated hernia, obstruction of the bowels, diarrhœa, and dysentery, have some symptoms in common with ordinary cases of irritant poisoning, and may still more nearly resemble certain exceptional cases. Though some of the objections founded on this possible resemblance of disease to poisoning are of little force, it may be well to point out some leading features in which the diseases in question differ from the usual effects of irritant poisons.

In *English cholera*, the evacuations very rarely contain blood, and there is no pain and constriction in the throat, though there may be some soreness as the result of constant efforts to vomit. The disease prevails chiefly in summer and autumn, and is rarely fatal. In *Asiatic cholera*, too, discharge of blood is a very rare occurrence, though the evacuations sometimes have a port-wine

tint; and the pain and constriction of the throat are wanting. In both diseases, the purging follows the vomiting much more rapidly than in cases of poisoning. There is one group of cases of poisoning by arsenic in which the symptoms so nearly resemble those of the two forms of cholera that medical men have fallen into error without seriously affecting their reputation. *Acute inflammation of the stomach,* except as the result of drinking hot or cold water, or as the effect of some irritant substance not esteemed poisonous, is very rare, and is not attended by pain and constriction of the throat, or by diarrhœa. *Acute inflammation of the bowels* affects their peritoneal covering, and is attended with constipation. *Distension of the stomach,* though an occasional cause of severe suffering and of sudden death, does not admit of being mistaken for the effect of a class of poisons of which vomiting is a leading symptom. Indeed, a full stomach is in itself the strongest possible presumption against irritant poisoning. *Rupture of the stomach* occurring, as it often does, during or directly after a meal, and through an effort to vomit, followed by sudden and violent pain, by collapse, and by death instantly, or in from four or five to less than twenty-four hours, might naturally raise a suspicion of poisoning, which nothing short of a post-mortem examination could set at rest. The same observation applies to rupture of the inner coat alone (a very rare occurrence) and to *rupture of the intestines or other viscera of the abdomen,* all of which accidents may be followed by vomiting with excruciating pain, and extreme tenderness of the abdomen, cold skin, feeble pulse, and symptoms of collapse with death within twenty-four hours. The effect of drinking *hot water* differs from that of the simple corrosives, chiefly in the absence of characteristic stains, and the negative result of an analysis. The drinking of *cold liquids* sometimes causes vomiting and purging, and other symptoms allied to those of irritant poisoning, and, in the absence of a complete history of the case, we may have to resort to the negative evidence afforded by the result of an analysis.

Of *vomiting and purging of blood* it will be sufficient to remark that they are not accompanied by urgent symptoms suggestive of the action of poison; of *diarrhœa* and *dysentery* that in the great majority of cases of poisoning, discharges from the bowels are associated with vomiting; and of *colic, strangulated hernia,* and *obstruction of the bowels* that they are attended by constipation, and that the vomited matters are often feculent.

The *post-mortem appearances* in irritant poisoning are not always characteristic; and it is true of the more common appear

ances, as of some of the more usual symptoms, that they may be occasioned by disease. Those usually specified are *Redness, Gangrene and Lividity, Softening, Ulceration, and Perforation of the mucous membrane.*

Redness of the mucous membrane may be produced by colouring matter: but when it is due to blood contained in the vessels, it may be traced to subsidence after death; to repletion of the small vessels by the contraction of the arteries; to transudation through the peritoneal covering of the liver or spleen; to congestion in cases of sudden death, especially if caused by asphyxia, when it often occurs in large bright patches; or, lastly, it may result from the flow of blood to the stomach which accompanies digestion. Sometimes, too, a remarkable redness of the stomach is found after death, without any symptoms having occurred during life to account for it. Hence, mere redness of the mucous coat of the stomach is not to be regarded as a proof of inflammation: but when it is combined with softening, putrefaction not having set in; when the membrane itself is covered with a thick and tenacious mucus; when it is opaque, so that when dissected off, it hides the finger over which it is stretched, the redness may certainly be attributed to inflammation. The same remarks apply to the intestines.

Gangrene and Lividity.—Gangrene of the mucous membrane is a well-known consequence of obstructed circulation in cases of hernia, and of internal constriction, and authors of reputation have described it as a consequence of acute inflammation; but it is probable that infiltrated blood blackened by acid secretions has been often confounded with it.

Lividity.—A minute injection of the vessels with black blood (figs. 51 and 52, pp. 414 and 415), may result from the action of an acid introduced from without, or generated within the body; and it can be produced after death by pouring any of the mineral acids into the intestines. Lividity or blackness, then, when not caused by gangrene, is not due to disease, but is the effect of some acid, swallowed or secreted. The blackness sometimes met with in the intestines in acute dysentery and enteritis, if not gangrenous, is probably due to the same cause. The deposit of black pigment known as melanosis, is distinguished by being arranged in regular, well-defined spots, without thickening of the membrane, or signs of surrounding inflammation.

Softening.—The mucous membrane may be softened or hardened by the action of poisons, or as the result of inflammation caused by them; or it results from disease; and it is a very common effect of the action of the gastric juice after death.

Softening due to the action of the non-corrosive irritants is attended by marks of acute inflammation, but, as a rule, morbid softening is not preceded by any characteristic symptoms.

Ulceration.—Ulcers of the stomach may be caused by disease, or by poison. Ulcers that result from cancer are readily recognised; but ulcers often occur in stomachs which, elsewhere, present a healthy appearance. Open ulcers, or the scars of ulcers, are present in about one dead body in ten, and in about one-fifth of the cases there is more than one ulcer. It is rarely much smaller than a fourpenny piece, or larger than a crown, but it may attain a diameter of five or six inches. It is usually round or oval; and presents the appearance of a shallow level pit, with a sharp, smooth, vertical edge, as though it had been punched out; and as the opening in the submucous areolar tissue is smaller, and the aperture in the peritoneum, if the ulcer perforates, still more minute, it has the appearance of a cone, with the base directed inwards. The mucous membrane and the areolar tissue are somewhat thickened by exsudation of lymph; and it is not unusual to find adhesions to surrounding parts. In some cases there is little or no appearance of inflammation round the ulcer; in most the edges are thickened and raised, and the thickening may extend to a circle of half an inch or an inch; and sometimes the surrounding parts are described as "a thick brawny mass," or as being blackened. These appearances have been mistaken for cancer. More than a third of the ulcers occupy the posterior surface of the stomach, and more than three-fourths either that part, the lesser curvature, or the neighbourhood of the pylorus. The ulcers caused by poisoning are the result of a more intense inflammation; and they are often found discoloured, as in the case of poisoning by nitric acid and iodine; or covered with a white powder, as in poisoning by arsenic; or coated with the decomposed poison, such as the black powder (minutely divided mercury), formed by the decomposition of corrosive sublimate, or the yellow sulphide of arsenic formed during the process of putrefaction after death.

Perforation of the Stomach may arise, from 1, Corrosion; 2, Inflammation, followed by ulceration; 3, Chronic gastric ulcer; and 4, The action of the gastric juice after death.

1. *Perforation from Corrosion.*—It is impossible, as already stated, to confound a perforation due to the direct *corrosive* action of an irritant poison with any perforation arising from natural causes acting either during life or after death. The state of the mouth, throat, and gullet, and often of the skin and clothes of the deceased, renders the distinction easy; and in many cases the

contents of the stomach or bowels escape into the cavity of the abdomen, and leave traces of their action on other viscera.

2. *Perforation from Ulceration*, the result of irritant poisoning, is very rare.

3. *Perforation from Chronic Ulcer* of the stomach is not a rare affection. It is not an infrequent occurrence in young females, from fifteen to twenty-five years of age, and often after slight symptoms of indisposition. The rupture generally takes place soon after a meal, more rarely as a consequence of sudden exertion, and it is instantly followed by sharp pain of the abdomen, and symptoms of acute peritoneal inflammation. There is little vomiting, and no purging; the patient dies in a state of collapse in from eighteen to thirty-six hours; but in some cases, when the stomach is nearly empty, the fatal event is postponed, the inflammation being of limited extent, or sub-acute in character. The opening in the peritoneum is generally small, and the ulcer has the peculiar characters just described. In one-third of the cases the perforation has been in the lesser curvature; in one-tenth at the pyloric extremity; in about one-twentieth on the posterior surface; in the same number, at the cardiac extremity; while in one-eighth of the cases two ulcers have been found opposite each other, on the anterior and posterior surfaces of the organ, the first being the seat of the perforation.* The absence of marks of acute inflammation, and of characteristic discolorations; the non-detection of poison in the stomach, or in the contents of the abdomen; the sudden occurrence of pain in the belly as the first symptom; the slight vomiting; and the absence of diarrhœa, distinguish this form of perforation from that due to poison.

4. The destruction, and consequent *perforation caused by the gastric juice after death*, has already been spoken of at p. 379.

The poisons which are neither corrosives nor irritants, or which, they act in either of these ways, prove fatal by their effect on e nervous centres, and, through them, on the brain, heart, or ngs, were formerly comprised under the two heads of *narcotics* d *narcotico-acrids*, oxalic acid (a corrosive in strong solution) ing the principal exception. These two classes are now more nveniently treated in different sections according as their most vious and striking symptoms, when given in full doses, and actg in their usual manner, are those of the brain, spinal cord, art, or lungs. They will be grouped, for the sake of convenence, as affecting the *brain*, *spinal cord*, *heart*, and *lungs* re-

* Consult Brinton 'On the Pathology, Symptoms, and Treatment of er of the Stomach;' and Taylor's Essay in 'Guy's Hospital Reports,' .8

spectively. This arrangement is based on some notable prevailing symptom or group of symptoms; not on the precise *modus operandi* or proximate and real cause of death.

1. The poisons which affect the *brain* may be distributed into three leading sub-classes: one group, of which *opium* is the type, causing sleep more or less profound; a second, of which *belladonna* is the type, producing delirium, with illusions; and a third, of which *alcohol* is the type, giving rise to exhilaration followed by delirium or sleep, or both successively or alternately, according to the dose and the constitution of the individual.

The group of poisons of which opium is the most conspicuous member, owes its importance less to the number of individuals which it comprises (for they are few), than to the habitual use made of them by large classes of persons, their constant employment in the treatment of medical and surgical maladies, the many accidents to which they give rise, and the many occasions on which they are employed by the suicide and murderer. Opium and its preparations alone are taken in nearly half the cases in which the poison can be identified.

The poisons of this sub-class present difficulties which do not occur in the case of irritants. Their symptoms more nearly resemble those of disease, and the post-mortem appearances are often indistinct, and, even when best marked, not highly characteristic. The chemical analysis also is less sure and satisfactory than in the case of irritant poisoning. The *symptoms* proper to this class are giddiness, headache, dimness of sight, extreme contraction of the pupil, noises in the ears, drowsiness and confusion of mind, passing into insensibility more or less complete. Delirium is rare, and paralysis, convulsions, and tetanic spasms only of occasional occurrence. There is no direct irritation of the stomach and bowels, but nausea and vomiting may occur, not at the commencement (as in the case of irritants), but when the patient begins to recover. Diarrhœa, also, is a rare incident. The *post-mortem appearances* consist in fulness of the veins and sinuses of the brain, effusion of serum beneath the membranes, at the ba[illegible] or into the ventricles; and in a few cases, extravasation of blo[illegible]

There are several diseases of the nervous centres, which in common with opium and its preparations, have coma more or less profound, and insensibility, more or less complete, as prominent symptoms. Apoplexy, cerebral effusion and turgescence, hydrocephal[illegible] blows and injuries of the head, febrile affections in certain stag[illegible] uræmia, the close of an epileptic fit, exposure to extreme co[illegible] and many poisons in certain stages of their action, are attend[illegible] by a profound sleep, from which the patient is not easily rous[illegible]

or even with coma and insensibility. The diagnosis of disease and poisoning during life will, therefore, sometimes be difficult, especially in infants and young children ; and after death the appearances of the brain may prove inconclusive. The discovery of disease of the kidney would furnish a probability of uræmia, and inflammation or chronic disease of the brain, or any considerable collection of serum upon or within it, would supply a sufficient explanation of death.

The sub-class of poisons, of which belladonna is the best example, is strongly characterized by delirium, spectral illusions, and a largely dilated pupil, with dryness of mouth and throat, and thirst, without any characteristic post-mortem appearance. Tetanic spasms, heightened sensibility, paralysis of the motor and sensitive nerves, coma, and insensibility, are among the exceptional symptoms. But great difference in degree, and strange varieties in the combination of these elements are observed in different cases of poisoning by the same substance. It must also be borne in mind that the delirium which is the leading symptom of the group is also a symptom often present in fevers and febrile disorders, and generally in diseases or injuries attended or followed by fever. Illusions also which are present in this form of poisoning are occasioned by many different, and by some trivial causes.

The poisons of this class owe their active properties each to one well-defined active principle (atropia and hyoscyamine), but they are commonly taken in the form of leaves, berries, seeds, or root ; and these, or portions of them, may often be identified in the contents of the alimentary canal rejected during life or found there after death. When intestinal irritation is added to the other symptoms, it is due to such solid matters, and not to these active principles.

The third sub-class of poisons, of which alcohol is the type, is characterized rather by the succession or combination of the symptoms, than by any one dominant symptom. Excitement of circulation and of the cerebral functions, passing into muscular weakness, shown by want of power as well as by want of co-ordination of movement and by double vision, and this into profound sleep, coma, and insensibility, constitute the usual group and succession of symptoms. Excitement followed by somnolency, and excitement culminating in maniacal violence, are not uncommon.

The more chronic form of poisoning by this class is characterized by tremor, delirium, and illusions, and the other symptoms of the disease known as *delirium tremens*.

It should be borne in mind that the ordinary effects of alcohol may show themselves as a result of the action of extreme cold,

and that they are sometimes present in the early stages of some mental disorders. The presence or absence of the odour of the poison in the breath of the patient greatly assists the diagnosis.

2. The poisons which affect the *spinal cord* consist chiefly of strychnia and the plants that yield it. The tetanic spasms which it occasions constitute the leading symptom and sign of their action, and these are present also in tetanus, traumatic, and idiopathic, and exceptionally, as one of several symptoms, in poisoning by many of the more active narcotics of every class. The differences between poisoning and disease will be indicated elsewhere.

3. The poisons which affect the *heart* kill either by sudden shock, or by syncope or collapse less rapidly induced. The first division comprises hydrocyanic acid and the substances that contain it, and oxalic acid and its salts. The second embraces aconite, digitalis, tobacco, lobelia inflata, veratria, and some poisons of less importance. A knowledge of their characteristic symptoms may be important in cases of sudden and speedy death. In the case of hydrocyanic acid we are happily greatly assisted by its characteristic odour; in poisoning by oxalic acid by its corrosive action on the gullet and stomach; and in that of aconite by its peculiar effect on the lips, tongue, and palate.

4. The poisons which act on the lungs, and so destroy life, have for their type carbonic-acid gas, which occasions the symptoms and post-mortem appearances present in death by asphyxia however brought about. The operation of this class may have to be distinguished from asphyxia produced by other causes; and it should be well understood that in poisoning by many of the more active poisons, and notably by prussic acid in doses short of a quickly fatal one, life may be destroyed by a remote action on the lungs producing fatal asphyxia.

CHAPTER III.

METHODS OF PROCEDURE IN CASES OF POISONING.

THE facts and discussions of the preceding chapter have prepared the way for a more direct examination of the duties that devolve on the medical man in cases of alleged poisoning.

Suspicion of poisoning may arise under very different circumstances. It may spring up in the minds of persons ignorant of the nature and action of poisons, suggested by some severe illness or sudden or speedy death, coupled with the suspicious conduct of some relative or friend; or it may occur to the medical man himself during his attendance on a patient; or, again, it may be the utterly groundless fancy of a person of unsound mind, such fancy constituting the leading feature of his malady, or one only of his many delusions. But, in whatever way the medical man may be brought to entertain and consider a suspicion of poisoning, the following summary of the leading circumstances to be attended to, and noted down, cannot fail to be of service :—

1. The state of the patient before the commencement of the symptoms, whether in good health or suffering from illness—the time at which they began, and at what interval after a meal, or after taking food, drink, or medicine—their nature, order, and time of occurrence, and the period of the commencement of any new symptom or train of symptoms: whether they followed the use of any new article of food or medicine; increased steadily in severity, or alternated with intervals of ease; and whether the exacerbations corresponded with a repetition of food or medicine; also the character of any substances which may have been rejected from the stomach, or passed from the bowels. The exact time of the death should be noted, and if the person is found dead, when he was last seen alive.

2. If the symptoms of poisoning showed themselves soon after a meal, minute inquiries should be made as to the cooking of the several dishes; the vessels used in the preparation of the food should be inspected, and their contents, if necessary, preserved;

and suspicious powders or liquids found in the house should be sealed and kept. If several persons have partaken of the same meal, care should be taken to ascertain what articles were taken by those who suffered, and by those who escaped, and in what quantities, and whether the same articles of food had been previously taken without bad effect by the persons attacked.

3. The vomited matters must be carefully collected, and removed from the clothing, furniture, &c., on which they had been rejected; and portions of the dress, furniture, or flooring may, if necessary, be reserved for examination.

But suspicions of poisoning may first occur to the medical man during a post-mortem examination, or he may be required to make such an examination in consequence of suspicions having already arisen in the minds of relatives, or in the course of an inquiry in the coroner's court. In certain cases, too, he may be required to conduct the disinterment as well as the post-mortem examination of a body supposed to contain poison. Hence the importance to the medical man of being furnished with a summary of rules and suggestions to guide him in this important and responsible duty.

Having observed the precautions insisted on at p. 242 as common to all post-mortem examinations for legal purposes, certain others proper to cases of suspected poisoning will have to be taken. These arise out of the fact that while poisons themselves, as well as their most notable effects, are found in the alimentary canal, they, and certain of their secondary effects, are to be sought after in the organs and tissues into which they are carried by the blood. The alimentary canal and the principal viscera or parts of them, and, in some cases, blood, or portions of muscle, will have to be set aside for more minute examination; and they may have to be forwarded to some skilful chemist for analysis, unless the person making the post-mortem feels himself competent to the task.

Prior to the inspection, one large wide-mouthed jar, of glass or earthenware, and a few smaller ones, should be got ready, which, if not new, should be repeatedly washed out with water and drained, so as to be quite clean. They should be furnished with clean ground-glass stoppers, or with new corks, or other non-metallic means of closure. The larger jar is for the intestinal canal and its contents; the smaller for the other viscera, or parts of them. The method of procedure, as far as it relates to the intestinal canal, must be governed by such considerations as the following:—When the poison is a corrosive its effects are to be looked for chiefly in the mouth, tongue, throat, windpipe, gullet,

stomach, and upper part of the small intestines, and, in case of perforation, in the contents of the peritoneum. But if the poison is one of those irritants which combine local action with remote specific effects, we may find marks of its direct action on the gullet, stomach, small intestines, and even on the whole intestinal canal; while the viscera to which it is carried with the blood may also become inflamed, and especially those engaged in the work of elimination, such as the kidneys and urinary organs, and the glands of the large intestines. In poisoning by alcohol, chloroform, hydrocyanic acid, opium, and the alkaloids, the local effects may be limited to the stomach and upper part of the intestines, but the three volatile poisons may be found in the serum of the brain. Lastly, animal or vegetable poisons taken in substance, whether as leaves, roots, fruit, or seeds, or as powder, may be found in any part of the alimentary canal.

Considerations such as these will determine the parts to be examined, as well as those to be reserved for further examination and analysis. In every case, the whole length of the intestinal canal should be carefully inspected, and especially the gullet, stomach, and upper part of the small intestines, the cæcum, and the rectum ; and these, with their contents (subject to exceptions arising out of the foregoing considerations) should be reserved. The examination on the spot must be so conducted as not to interfere with the more minute examination and chemical analysis afterwards to be made. The stomach should be first secured by ligatures at the lower end of the gullet and upper end of the duodenum, and then drawn out and placed in a large clean plate or chemical dish. It should then be slit from end to end in the line of the lesser curvature, its contents inspected and emptied into one of the jars, the inner surface carefully examined, and the ligatures removed. Double ligatures should then be applied to those points of the gullet and small intestines which present characteristic appearances. The stomach and the parts thus selected are then to be placed in one of the jars. The cæcum, with some inches of the lower part of the small and upper part of the large intestines, should be treated in the same way, as well as such other parts of the canal as are inflamed, or contain matters worth examining. In the case of the corrosive poisons and stronger irritants, the gullet, with the upper part of the windpipe and the tongue attached, will have to be removed and secured. Of the other viscera, the liver (or part of it), as the organ to which poisons are first carried by the circulation, the kidneys, as active organs of elimination, the contents of the urinary bladder, the heart, as a muscular structure rich in blood, and portions of

blood itself, should be reserved; and in cases of poisoning by such volatile substances as alcohol, prussic acid, and chloroform, the serum of the brain and parts of the organ itself.

The organs and their contents thus reserved for further examination having been placed in separate jars, these must be securely closed by stopper or cork, covered with leather or stout paper firmly fastened round the neck, no sealing-wax, metal, or substance containing metal, being used. Tickets should then be attached, with numbers corresponding to those used in a description dictated at the time of the inspection, and verified immediately afterwards. The several jars should be carefully packed, and the parcel secured by seals. Letters of advice forwarded by post, and all other communications relating to medico-legal examinations in progress should be doubly secured, first by wafer or gum, and then by seal; and should, if possible, be posted by the writer; all other correspondence being carefully avoided.

That these minute precautions are not needless may be inferred from a fact reported by Tardieu and Roussin. Oxide and carbonate of copper were found on the mucous membrane of the stomach, through a large pin having fallen upon it after the autopsy.

In cases of exhumation, the character of the soil, the mode of interment, the state of the grave, of the coffin and of the grave-clothes, as well as the position and appearance of the body itself, should be noted; and, if the earth is in contact with the corpse, a few pounds of it may have to be reserved for analysis. If the body has been interred in lead or a close-fitting coffin, and happens to adhere to its sides, the inspection should, if possible, be made without removing it.

The viscera and their contents having been carefully removed from the jars that contain them, and care being taken to preserve their identity, will have to be submitted to two successive examinations, the one *physical* the other *chemical.*

The *physical examination* will be directed mainly to the stomach and intestines, and the matters adhering to their inner surface. The odour of the contents of the stomach as indicating the presence of alcohol, phosphorus, hydrocyanic acid, chloroform, and laudanum, and a few poisons less commonly employed, will have to be noted. If in doubt as to the existence of any characteristic odour, the organic matters may be warmed to a temperature not exceeding 100° Fahr. Each part of the intestinal canal should then be in turn spread out on a clean sheet of window-glass, with the internal surface outwards, which should then be searched by transmitted and reflected light, first with the naked eye, then with a hand-lens; its appearance described; and any substances

that may attract notice by their form or colour particularly examined. Such small portions of the organ as present the most marked appearances may then be cut out, spread on clean glass slides, and examined under the microscope. By this means we may ascertain the kind of food that has been recently taken, whether it consisted of, or comprised, animal matters revealed by muscular fibres; or adipose tissue, with its polyhedric cells and fat globules wholly soluble in ether; or vegetable matters, with their spiral vessels, stomata of leaves, and chlorophyl soluble in alcohol, and imparting to it its own colour; sometimes also characteristic woody fibre. Or we may find evidence of a particular kind of farinaceous food in the characteristic starch granules of wheat, potato, rice, maize or Indian corn flour, oatmeal or arrowroot, or the spores of mushrooms.*

We may also find more or less firmly attached to the mucous membrane certain white powders, as magnesia or its carbonate, or the bicarbonate of soda taken with a meal or after it, or calomel taken as a medicine, or arsenious acid given as a poison, and possibly undissolved corrosive sublimate, or imperfectly dissolved crystals, say of oxalic acid.

We may also recognise the corrosive action and characteristic discolorations of the mineral acids, and, when the stomach is far advanced in putrefaction, the sulphides of the metals (arsenic yellow, antimony orange, mercury black) or finely divided mercury as a grey coating; as also the green aceto-arsenite of copper, the shining green and gold specks of cantharides, the brown powder of nux vomica, the blue of Battle's vermin killer; and, as seen in the dark, the phosphorescent light of phosphorus.

The colour and consistence of the contents of the stomach will afford important indications; black, dark brown, or greenish brown grumous matter of the action of the mineral acids and oxalic acid on the blood, food, and tissues; and green matter, of the eating of leaves from the hedges. Sometimes, too, we may find fragments of leaves, buds, or berries, large enough for identification.

When the fruits of poisonous plants are eaten by children, we may find in the stomach or intestines the seeds which they contain. Those of the plants that require the microscope for their identification are shown in the annexed figure, in which—1. Shows the seed of Belladonna; 2. That of Hyoscyamus; 3. That of the Papaver somniferum; 4. That of Digitalis; and 5. That of the Lobelia inflata.

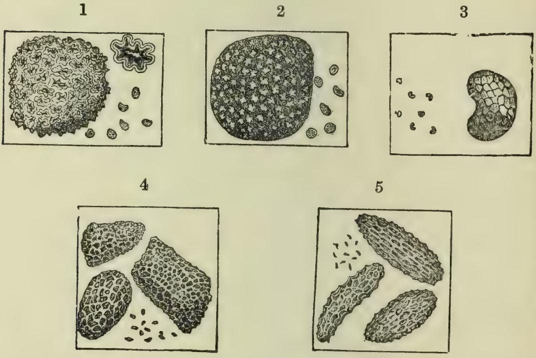
Portions of the larger poisonous seeds, such as stramonium,

* For the characteristic forms referred to in the text, consult the 'Micrographic Dictionary' of Griffith and Henfrey.

colchicum, aconite, castor, and croton, may also be identified by the colour and markings of their cuticles.

The advantage that may accrue from a thorough examination of the contents of the stomach is well shown by a case given by Tardieu. A child twelve years old died at school after ten hours

Fig. 45.



of acute suffering on the day on which its stepmother brought it several good things to eat. Among the contents there were found certain fragments of crumb and crust of bread, which, when examined by the microscope, were found covered with fungous growth, showing that the bread was mouldy. Arsenious acid, in powder, was also found in large quantity. The fact of the mouldy bread was noted down, but no importance seemed to attach to it, till, at the trial, one of the witnesses, a servant of the stepmother, stated that her mistress was in the habit of carrying to the child slices of bread and jam, but that on the day of the death she sa[id] she would not take it, because the bread was mouldy. It ha[d] been in that state for one or two days.

Having indicated the precautions to be taken in searching th[e] portions of the alimentary canal reserved with their respectiv[e] contents for chemical examination, a few hints will now be offere[d] (as reminders to those who possess practical experience, and a[s] necessary instruction to the learner) under the distinct heading[s] suggested by the following considerations.

The poisonous substances submitted to the chemist for exami[-] nation may be in their pure unmixed form, whether solid or liqui[d]

often in large quantities; or they may be small remnants of powder or crystal adhering to papers from which they were taken, or to cups or glasses out of which they were swallowed. In other instances the poison is dissolved in some common beverage, as beer, brandy, rum, tea, or coffee. In other cases, again, it has to be sought for in the urine; or in the serum of a blistered surface, or of a serous sac after death; or lastly, it may be contained in mixed articles of food of some consistence, spilled in the act of swallowing, voided during life from the stomach and bowels, or found in them after death; or in such thick viscid matters as the blood; or even in the solid structures of the body.

Systematic Analysis.—Toxicological analysis pre-supposes a knowledge of ordinary chemical methods, so that it is unnecessary to describe them here. The toxicologist has usually to search for and detect poisonous substances in organic mixtures, and in the fluids and tissues of the body. Fortunately in most cases the symptoms during life, and the appearances after death, are such as to indicate the nature of the poison, and thus to make his research largely a question of verification; but cases occur in which these indications are so uncertain as to necessitate an exhaustive examination for poisons in general. According to circumstances he may limit his research to the detection of a corrosive poison, such as a mineral or vegetable acid (especially the oxalic) or caustic alkali; of some volatile poison, such as phosphorus or prussic acid; of some alkaloid or organic principle; or of some metallic poison. A research thus limited is comparatively simple. But where the indications are not sufficient to narrow the research in this manner, it is necessary that some plan should be followed in which the examination for one class of poisons shall not interfere with the analysis for another. Apart from the mineral acids and oxalic acid, the reactions and effects of which are usually so distinct as to require analysis merely for identification, the plan recommended by Otto * gives very satisfactory results. Search is to be made first for volatile poisons; next for alkaloids and organic principles; and lastly for metallic poisons.

In operating on substances involving important issues, it is advisable to use only one-third or one-half of the material at one time, in case of accidents, and to reserve the remainder for further research if necessary.

a. Search for Volatile Poisons.—Volatile poisons which

* Ausmittelung der Gifte, 5te Auflage, 1876.

indicate their presence by their characteristic odour in most cases, are to be separated by distillation, the phenomena and products of which give characteristic reactions. The chief poisons to be thus sought for are phosphorus, hydrocyanic acid, alcohol, ether, chloroform, nitro-benzol, and carbolic acid.

The substance is placed in a flask, acidulated if necessary with tartaric acid, heated in a water-bath, and the vapours condensed by a Liebig's condenser, and collected in the appropriate receiver. (See Fig. 53, p. 430.)

In order to ensure the detection of phosphorus, the process of distillation must be carried on in the dark, to render evident the luminosity which is so characteristic of this substance. The special arrangements and mode of testing the distillate for the various volatile poisons will be described hereafter under their appropriate headings.

b. Search for Alkaloids.—Under this head is included the search, not only for the alkaloids proper, but also for such active principles as digitalin, cantharidin, and picrotoxin.

Various methods have been suggested for the separation of these organic substances, but the method of Stas, as modified by Otto, and known as the Stas-Otto process, is the one most generally followed.

The method is based on the following properties of the alkaloids. Alkaloids are either *liquid* and *volatile*, as conia and nicotine, or *fixed*, as strychnia, morphia, veratria; also cantharidin, digitalin, and picrotoxin.

They are all insoluble or nearly insoluble in water. But colchicin and picrotoxin are exceptions to this rule, colchicin being readily soluble in cold and picrotoxin in boiling water.

All the alkaloids are soluble in alcohol: also in benzol, chloroform, and amylic alcohol. All the important alkaloids are soluble in ether with the exception of morphia, which in its crystalline form is almost insoluble.

The salts of the alkaloids are mostly soluble in water, especially on heating. Some which are insoluble or nearly so, are readily dissolved by the addition of a little acid.

The caustic alkalies and the alkaline carbonates set free the alkaloids from their salts. When the liquid containing the alkaloid thus set free is shaken with ether or amylic alcohol, the alkaloid is dissolved and remains on evaporation of the solvent.

The salts of the alkaloids, however, are as a rule not soluble in ether, or amylic alcohol. Owing to this property, the alkaloids can be freed from organic matter soluble in these reagents, and thus obtained in a state of purity.

The alkaloids in addition to their special reactions are, with few exceptions, precipitated by the following reagents:—

1. A solution of iodine in iodide of potassium (Herapath, Wagner)—this gives reddish-brown precipitates.

2. Potassio-mercuric-iodide—a solution of mercuric iodide in iodide of potassium (Winkler)—forming light-coloured precipitates, amorphous or crystalline.

3. Phospho-molybdic acid (de Vry, Sonnenschein). This may be made by adding to a solution of molybdate of ammonia, phosphate of soda in the proportion of one-fifth of the molybdic acid, and sufficient nitric acid to make a yellow solution. This forms amorphous yellowish precipitates, some of which turn greenish or blueish afterwards. This reagent also precipitates digitalin.

4. Phospho-tungstic acid (Scheibler)—a solution of tungstate of soda with the addition of phosphoric acid. This gives precipitates similar to those with phospho-molybdic acid, but less stable.

5. Phospho-antimonic acid (Schulze)—phosphate of soda with the addition of perchloride of antimony. This gives amorphous whitish precipitates.

6. Potassio-bismuthic-iodide—a solution of iodide of bismuth in iodide of potassium (Dragendorff). This reagent gives amorphous orange-coloured precipitates. Among other precipitants are also to be mentioned chloride of platinum chloride of gold, perchloride of mercury, and solutions containing tannin.

The organic matters in the first instance, or the residue of the distillation for volatile poisons, are to be digested at a gentle heat for some hours with double the weight of strong alcohol, free from fusel oil, and rendered distinctly acid with tartaric acid. After cooling, the mixture is to be filtered, the residue washed with strong alcohol, and the mixed filtrates evaporated at a gentle heat in a water-bath to expel the alcohol. On the evaporation of the alcohol, fatty and resinous extracts separate themselves; and the watery residue is to be freed from these substances by filtration through a filter moistened with water. The filtrate is then to be evaporated in a water-bath to the consistence of a syrup. This is to be thoroughly extracted with absolute alcohol added in successive portions. The alcoholic solution is to be decanted clear, or passed through a filter moistened with alcohol, and again evaporated. The residue is to be dissolved in a little water. If the solution is very acid, it is to be cautiously neutralised with dilute caustic soda, so as however to leave it still distinctly acid, and then shaken up with ether.

Out of this *acid* solution ether dissolves, along with some colouring matters, cantharidin, colchicin, digitalin, and picrotoxin

(also traces of atropia and veratria). The ethereal layer with these substances in solution, is to be separated from the watery layer, and the process repeated until the ether becomes no longer coloured.

On evaporation of the ethereal solution cantharidin, colchicin, digitalin, and picrotoxin remain, along with fat and extractives. Hot water dissolves out colchicin, digitalin, and picrotoxin, but not cantharidin. The further characteristics of these substances will be found under their respective headings.

The acid watery solution which remains after the above extraction with ether, contains all the other alkaloids. The ether is first to be driven off by heat, and then the solution is to be made strongly alkaline with caustic soda (or carbonate of soda), and then repeatedly shaken with ether. Ether dissolves all the important alkaloids with the exception of morphia, which is to be extracted by the method given below.

A portion of the ethereal solution is to be evaporated at a gentle heat in a watch-glass in order to ascertain whether any alkaloid is present, and whether this is liquid or fixed. The liquid alkaloids conia and nicotin remain on evaporation as oily drops of a characteristic odour. Should the presence of these be indicated, the mixed ethereal solutions are to be shaken with a few pieces of chloride of calcium in order to abstract the water, and the whole evaporated in a watch-glass; fresh portions of the liquid being added successively until the whole of the ether is driven off. The residue is then ready to be tested by the general reagents for alkaloids, and by the special reactions characteristic of each.

If a fixed alkaloid is indicated by the preliminary evaporation, it will in general not be sufficiently pure for the application of the necessary tests. To effect this the ethereal residue is to be mixed with water and rendered distinctly acid by a little tartaric or sulphuric acid. The alkaloids are thus converted into acid salts and are taken up by the water, while the organic matters are retained in solution by the ether.

The ether is to be separated, and fresh ether added if required to purify the watery solution of the salt still further. The watery solution freed from ether is then to be made strongly alkaline with caustic soda, and again shaken up with ether, which dissolves the alkaloid again set free. On evaporation of the ether, the alkaloid is left. It may, if necessary, be again subjected to the like treatment if it is not sufficiently pure.

The residue is then to be tested by the general reagents for alkaloids, and for this purpose the more or less impure and not

distinctly crystalline residue which forms at the margin may be employed, while the more distinctly crystalline and purer material at the bottom is reserved for the special reactions of the individual alkaloids.

In applying these tests, a minute portion of the substance is to be removed and dissolved in a small quantity of water acidulated with hydrochloric acid. Drops of this solution may then be placed on slides, and tested carefully with the different reagents. The tests may be applied on black paper to indicate cloudiness or precipitates, or on a white ground when colour reactions are involved, and examined under the microscope when necessary.

In applying liquid reactions to such minute quantities, the following apparatus will be found very serviceable. The reagent should be kept in a bottle furnished with a pipette, as indicated in the annexed figure (Fig. 46), and the testings, when carried on on a flat surface of porcelain or glass, should be made by the instruments shown in Fig. 47. The pipette, and its uses, and those of the

Fig. 46.

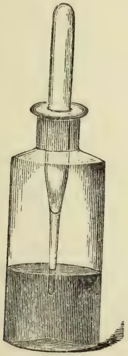
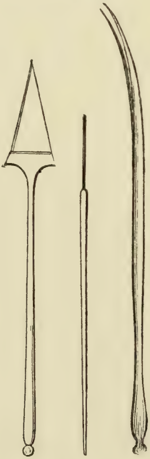


Fig. 47



small instruments sketched in Fig. 47, are described in the Appendix under the heading "Sublimation and Diagnosis of the Alkaloids," a subject which in the last edition of this work was treated in the text.

From the alkaline solution above described, ether separates all the more important alkaloids, liquid and fixed, with the exception

of morphia. These are the liquid and volatile alkaloids, conia and nicotin; and the fixed alkaloids, aconitin, atropin, hyoscyamin brucia, strychnia, veratria, and physostigmin, (also colchicum and digitalin). Certain active principles which occur in opium along with morphia, viz. codeia, narcotin, papaverin, and thebaia may also be mentioned.*

As has been stated, morphia is not (or only very sparingly) taken up by ether out of the alkaline solution. It is to be separated as follows:—The ether is to be driven off by evaporation, and the morphia, if present in quantity, can be separated in the crystalline form, by the addition of excess of a concentrated solution of ammonium chloride, and allowing the mixture to stand for some time. The ammonia takes the place of soda in the solution, and precipitates the morphia in the pure crystalline form. If in less quantity, the morphia can be obtained better by shaking this liquid with amylic alcohol, which dissolves the morphia and leaves it on evaporation.

Or the original alkaline solution may be acidulated with hydrochloric acid, and then rendered alkaline by ammonia. The morphia is separated and is to be dissolved out by shaking with amylic alcohol. If not sufficiently pure it may again be dissolved in acidulated water, shaken up with amylic alcohol, which will remove the organic matter, and then again rendered alkaline by ammonia and shaken up with amylic alcohol, as before. On evaporation of the amylic alcohol the morphia is left in a condition fit for the application of tests. †

After morphia, curarin and narcein may still have to be looked for, but they are not of much importance medico-legally.

c. Search for Metallic Poisons.—The organic matters, or residue of the operation for the detection of volatile and organic poisons, are to be finely divided and drenched with strong hydrochloric acid, and sufficiently diluted to form a gruelly mass.

* Various observations of recent years (Schwanert, Selmi, &c.) indicate that certain substances resembling in many respects the liquid or fixed alkaloids, and separable by this process, may be found in decomposing organic matters. Great care is therefore requisite in the examination of the residue left on evaporation of the ether, and the special chemical or physiological reactions of the supposed alkaloid must be clearly obtained before its presence can be positively affirmed.

† Erdman and Uslar employ amylic alcohol as the solvent instead of ether as in the Stas-Otto process, but though it is the best solvent for morphia, it has no advantage as regards the other alkaloids, and is besides extremely unpleasant to work with.

Rodgers and Girdwood prefer chloroform to ether, as the solvent, especially when the presence of strychnia is indicated.

Dragendorff employs petroleum-ether, chloroform, benzol, and amylic alcohol in the various steps of his method for the extraction of alkaloids. For a full description of this method, see "Gerichtlich-Chemische Ermittelung von Giften, 2nd Edition, 1876.

This is to be heated with the addition of chlorate of potash in successive portions until the whole is converted into a yellowish liquid. By this method chlorine is set free, and the organic matter destroyed, while the metals are dissolved in the acid liquid. (Silver, lead, and barium may remain undissolved). The yellowish solution must be heated till all the chlorine is driven off.

The acid solution so obtained is to be filtered, and is now ready for the application of several preliminary tests.

To separate the metals the liquid properly diluted is to be warmed, sulphuretted hydrogen led through it to complete saturation, and allowed to stand for many hours. Fom the acid solution sulphuretted hydrogen precipitates as sulphides, copper, lead, and mercury (dark), arsenic, antimony, and tin (yellowish). If no precipitate occurs, neutralisation with ammonia and the addition of sulphide of ammonium will precipitate metals belonging to the iron group, viz. iron (black), manganese (pink), zinc (white), and chromium (green). The material which remains after digestion with hydrochloric acid and chlorate of potash may have to be examined for the presence of lead, silver, and barium.

Such is a general outline of systematic toxicological analysis, but such modifications as may be requisite in any given case must depend on the general chemical knowledge of the analyst.*

* In addition to works on chemical analysis in general, reference may be made to Bowman's Med. Chemistry, edited by Bloxam; Odling's Course of Practical Chemistry; Horsley's Toxicologist's Guide; Wormley's Micro-Chemistry of Poisons; Otto's Ausmittelung der Gifte; Mohr's Chemische Toxicologie, and Dragendorff's Gerisch. Chem. Ermittelung von Giften.

CHAPTER IV.

CORROSIVES.

I. THE MINERAL ACIDS.

SULPHURIC, NITRIC, AND HYDROCHLORIC.

II. THE ALKALIES AND THEIR CARBONATES.

POTASH, SODA, AND AMMONIA.

THE mineral acids, with the alkalies and their carbonates, make up a well-defined group of *simple corrosives*—that is to say, of poisons of which the symptoms are due solely to energetic local action. They have no specific remote effects; and in this they differ from the metallic corrosives (the chlorides of mercury, antimony, and zinc, and the nitrates of mercury); from oxalic acid in strong solution; and from phosphorus and iodine in substance.

I. THE MINERAL ACIDS.

Several cases of poisoning by these acids occur every year, most of which are by sulphuric acid, the remainder by the nitric, and hydrochloric acids.

Poisoning by these acids is rarely a homicidal act; but they have been given to adults in place of medicine, or poured down the throat while they are asleep or intoxicated: and more frequently to young children by their mothers or nurses. In infants the act is homicidal, in children either homicidal or accidental, in adults generally suicidal. The mineral acids have also been administered otherwise than by the mouth; and mixed with other matters, such as aloes, laudanum, &c.

These acids (generally the sulphuric, occasionally the nitric,) are also used to disfigure the person, destroy the clothes, o[r] imitate the destructive action of moths.

The Mineral Acids have the following familiar properties:— they char and destroy organic matters; discolour, and corrode, o[r] injure, the texture of black cloth; redden vegetable blues; an[d] alter or discharge the colour of dyed articles of dress.

Symptoms.—Those common to these acids are:—a sour tast[e] and burning pain in the mouth, throat, and gullet, *immediatel[y]*

after swallowing the acid, followed by excruciating pain, eructations, constant retching, and vomiting of a brownish or blackish matter containing blood, coagulated mucus, flakes of epithelium, or of the lining membrane of the gullet and stomach. The act of swallowing is painful, or even impossible, and there is intense thirst. The bowels are costive, the urine scanty or suppressed, and there is constant tenesmus and dysuria. The pulse is generally small and frequent, the respiration catching, and sometimes laborious, and the countenance expresses intense anxiety. In some cases the acid passes into the windpipe, and causes a harassing cough, with croupy respiration and hoarse voice, and, the accumulation of tenacious mucus discharged with difficulty, and threatening instant suffocation. The lips are shrivelled, and blistered or excoriated, or they present spots of the characteristic colour of the acid bordered with red; the cheeks and chin are spotted, and discoloured streaks run from the angles of the mouth. The inside of the mouth is white, shrivelled, and corroded, brown or yellow, and the teeth loose and discoloured. The tongue is either white and polished, or discoloured. Distinct marks of the acid are also commonly found on the neck or fingers, and on the clothes; and the vomited matters, if rejected on a limestone pavement, effervesce. In fatal cases, death is generally preceded by collapse, the intellectual faculties remaining clear to the last. Some patients die convulsed, others suffocated. Severe nervous symptoms, such as trismus, tetanus, epilepsy, and delirium, are occasionally present, and rashes sometimes appear on the skin.

These poisons may destroy life in such small quantities as one or two drachms, and in such short periods as two hours or less. But the patient may linger for days, weeks, or months. In chronic cases he is feverish; has a dry skin and frequent pulse; occasionally vomits his food mixed with flakes of false membrane or portions of the lining membrane of the gullet and stomach, similar flakes being sometimes discharged from the bowels; and suffers from salivation with fœtor of the breath. The belly is tense; the breathing short and difficult; there are pains and cramps of the limbs; digestion is impaired; all the functions of the body languish; extreme emaciation supervenes; and death happens in a period varying from a fortnight to some months. Other patients recover imperfectly, to become dyspeptic valetudinarians for life. Rather less than half the adults recover completely.

The mineral acids have been injected into the bowels or womb, or poured into the ear; and in all these ways have proved fatal.

Post-mortem Appearances.—The lips, chin, and other exposed parts of the body are marked by the acid in the manner just described. The lining membrane of the mouth, tongue, and throat is white, yellow, or brown, shrivelled and corroded; and sometimes coated as with white paint. Portions of the tissues are highly inflamed; sometimes they are gangrenous, sometimes corroded. The epiglottis may be contracted or swollen, the rima glottidis contracted, and the larynx inflamed. The gullet presents the same appearances as the mouth and throat, and it is common to find its lining membrane more or less extensively detached. (See fig. 50, p. 415.) Sometimes it presents the peculiar wrinkled and worm-eaten appearance shown in fig. 49. In rare cases it becomes the seat of ulceration, and is perforated. Occasionally it entirely escapes. The stomach is usually distended with gas, and filled with a yellow, brown, or black glutinous liquid, which also extends into the gullet and commencement of the small intestines. The lining membrane is highly inflamed, its vessels are minutely injected with black blood, as in fig. 51, p. 415; or black blood is extravasated into its substance; the rugæ are softened, and the coats destroyed, ulcerated, and perforated. The pylorus is commonly contracted. The perforations are generally circular, situated at the posterior part of the organ, and surrounded by inflammation and black extravasation. The duodenum presents appearances similar to those found in the stomach. The peritoneal surface of the viscera, even where there is no perforation, is highly inflamed, and coated with coagulable lymph. When the contents of the stomach escape into the cavity of the abdomen they act on the viscera, and impart to them a peculiar unctuous feel. The inflammation may extend into the chest, and the thoracic surface of the diaphragm become coated with lymph. The blood in the large vessels is often found firmly coagulated. The urinary bladder is generally empty and contracted. The appearances just described will of course vary with the strength and quantity of the acid, the full or empty state of the stomach, or the part of the alimentary canal the poison reaches. It may not pass beyond the mouth, it may not enter or pass the stomach, and its action may even be limited to the upper part of the windpipe.

Diagnosis. This is easy. The intensely sour taste, the *immediate* commencement of the symptoms, the disorganization of all the parts which the acid touches, the absence of diarrhœa, the stains on the skin, and the injury to the clothes, form a combination not to be attributed to any other cause. In most cases, both

symptoms and post-mortem appearances are decisive of themselves, but when combined they leave no room for doubt, even without the evidence afforded by chemical analysis.

Treatment.—The best antidote is calcined magnesia, or the carbonate, mixed with water, or milk and water. But as these are not likely to be at hand, chalk or whiting, the plaster from the ceiling or wall of an apartment, milk, oil, or soap-suds, or soda or potashes, mixed freely with water should be given without delay; followed by milk, mucilaginous and oily drinks, and dilute alkaline solutions given frequently for several hours or days.

The corroded and softened state of the parts forbids the use of the stomach pump, even if it were possible to introduce it; but if the patient cannot swallow, a cautious attempt may be made to introduce the tube into the œsophagus beyond the obstruction. The subsequent treatment must depend on the nature and severity of the symptoms. Leeches to the pit of the stomach are likely to afford relief, and, if grateful to the patient, ice in substance, or iced drinks may be prescribed. The bowels must be kept open at first by injections of thin gruel, and as soon as aperients appear safe, by castor oil given in milk. Excoriations on the surface must be treated as burns.

I. SULPHURIC ACID. (*Oil of Vitriol.*)

This acid is much more frequently administered than the other mineral acids, and it ranks fifth among the poisons in order of frequency.

The strong acid is sold by druggists and oilmen as "oil of vitriol" to blacking makers; and the dilute acid as "vitriol," "spirit of vitriol," or "essence of vitriol," for cleaning utensils of copper or brass, at 1*d.* for four ounces, or 2*d.* or 3*d.* the pound. In medicine, the strong acid is used in the cure of ringworm, and the dilute acid is often prescribed as an internal remedy. In the arts the acid is largely used for the manufacture of other chemicals; and, as impure specimens sometimes contain large quantities of arsenic, that poison is often found in drugs and chemicals as an impurity.

For medico-legal purposes, we may have to examine the acid as—1. *The strong acid.* 2. *The dilute acid.* 3. *In stains on cloth.* 4. *In organic mixtures.*

1. *Strong Sulphuric Acid.*

A heavy oily liquid, not fuming, colourless when pure, but as found in commerce, of a light brown tint. It chars organic

matter, and, when added to water, gives out heat. When heated with copper turnings, sulphurous acid is given off, which liberates iodine from iodic acid. It develops characteristic colours with several of the alkaloids, with or without the aid of heat.

2. *Dilute Sulphuric Acid.*

A colourless, intensely sour liquid, which reddens litmus, and chars paper when dried,* and gives with a solution of nitrate of barium a white precipitate, insoluble in nitric acid. This precipitate being collected, washed and dried, mixed with black flux, and heated on charcoal in the reducing flame of the blowpipe, is converted into the sulphide; and this moistened with dilute hydrochloric acid, gives off sulphuretted hydrogen. By this threefold process an acid liquid is proved to contain sulphuric acid; but not necessarily as free acid. It may be a constituent of a supersulphate, such as alum; or of a neutral sulphate, such as Epsom salts, with some other free acid in excess. The presence of a saline ingredient may be verified by evaporating the acid liquid; and the volatile acids, such as the acetic and hydrochloric, may be separated by distillation, and identified by appropriate tests. Wormley recommends veratria as the best test for the free acid, and one in every respect superior to Runge's cane-sugar test. A fragment of the alkaloid dissolved by heat in a liquid containing the one-thousandth of a grain of the free acid, forms a colourless mixture, which evaporated to dryness leaves a deposit with a fine crimson border.

3. *Stains on Cloth.*

The strong acid stains black cloth first red, then brown, and corrodes it. The stain continues moist for months or years, and has an acid reaction. The dilute acid produces the same change of colour, with less corrosion; but the stains are dry.

To detect the acid, boil the stained fragment of cloth in a little distilled water, filter the liquid, and test for the free acid. Evaporate a drop of the filtrate on a glass slide, and if a visible stain remains, examine it for saline matters. Examine an unstained portion of the cloth in the same way.

Clean linen and cotton fabrics corroded by the acid may be submitted to destructive distillation in a reduction-tube, in the

* This charring property is so remarkable as to constitute a test. If a strip of filtering paper be dipped in a liquid containing a single minim of the strong acid to 800 of water, and then dried before a fire without scorching the paper, the part touched by the acid becomes black and brittle. Hydrochloric acid has the same property, though in a lower degree.

mouth of which a slip of filtering paper, moistened with solution of starch, and sprinkled with iodic acid, is placed. The iodide is disengaged, and the blue iodide of farina is formed. This process is not applicable to woollen textures, which contain sulphates, to the coats of the stomach, or to its contents.

4. *Organic Mixtures.*

Liquids containing organic matter, such as tea and coffee, beer and porter, if thick and turbid, must be boiled with distilled water, and filtered; if clear they may be filtered at once. The nitric acid and nitrate of baryta test throws down a coloured precipitate, which being collected and boiled in strong nitric acid, to destroy the organic matter, is converted into sulphide of barium, as above.

The contents of the stomach, or the vomited matters, will have a strong acid reaction if no antidote has been given; but if the case has received medical treatment, or the patient has survived some time, they may be neutral or even alkaline.

a. If the contents have an acid reaction, it is probably due to a free acid, which may be sulphuric, or one of the two acids usually found in the stomach, the acetic and hydrochloric. These acids may be separated by distilling the filtered liquid (see Hydrochloric Acid), to the consistency of a thin syrup. If the tests for hydrochloric and acetic acids give a negative result, the liquid in the retort must be diluted, filtered, and tested for sulphuric acid. But if the product of distillation contains either acid, we dilute the liquid, and continue the distillation, adding fresh water if necessary, till all trace of these acids disappears. The fluid remaining in the retort is then to be tested for sulphuric acid.

If the fluid has an acid reaction, and also leaves a saline deposit on evaporation, and the result of distillation proves that the free acid is the sulphuric, we are dealing either with a supersulphate, such as alum, or with a sulphate, such as Epsom salts, combined with free sulphuric acid. In the latter case, we add carbonate of baryta, till effervescence ceases, and calculate the quantity of free acid from the weight of the resulting sulphate of baryta.

b. If the organic matters have an alkaline reaction, or are neutral, they must be boiled in distilled water, and filtered; the tests being applied to the filtered liquid.

If carbonate of lime has been given as an antidote, the resulting sulphate must be dissolved by boiling with nitric acid.

If the quantity of acid detected by any of these processes is very small, there is no proof that it has been swallowed; for the secretions of the stomach always contain some neutral sulphates.

Nor would the discovery of sulphate of magnesia, prove the administration of the free acid, for the salt itself may have been given as an aperient. The discovery of sulphate of lime, however, by proving the use of chalk as an antidote, would be as conclusive as the finding of the free acid.

But where the characteristic appearances of poisoning with sulphuric acid are present, chemical analysis becomes superfluous.

Sulphuric acid has been detected in the blood and also in parts of the body to which it must have been conveyed by the circulation—in the peritoneum, pleura, heart, and bladder, and even in the liquor amnii, and body of the fœtus. The milk of nurses taking the acid has produced disordered bowels and convulsions in the infants suckled; and in one case* the matters voided from the bowels were found to corrode the napkin.

Quantitative Analysis.—Use for this purpose the precipitated sulphate of baryta, boiled in pure nitric acid, washed and dried. 100 parts of the sulphate contain $41\frac{1}{2}$ of strong acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described at p. 403, but severe in proportion to the strength and corrosive properties of the acid. Severe nervous symptoms are sometimes present, such as locked-jaw, rigid spasms of the extremities, epilepsy, and delirium.

Diagnosis.—The dark-brown stains on the skin, and the moist brown corroded stains on black cloth, are characteristic.

Post-mortem appearances.—Those described at p. 404; but the disorganization greater, and perforation more frequent (about a third of the cases), than in poisoning by the other mineral acids. The colour of the epithelium and mucous membrane dark-brown or black, as if charred; while in cases of poisoning by nitric acid it is more commonly yellow or green. When thickly coated with mucus, the lining membrane of the mouth and alimentary canal seems smeared with white paint. This is the effect of the acid on the secretions of the canal after death (Dr. Chowne). The post-mortem effect on the mucous membrane itself is to render it yellowish and brittle, to bleach the muscular and peritoneal coat, and to char the blood in the vessels (Orfila).

Fatal dose.—In the adult, one drachm; in an infant five weeks old, half a drachm. Four ounces have been swallowed by an adult without fatal consequences.

Fatal period.—*Shortest* one hour: in a child, "*almost immediately.*" Life may be prolonged for several days, weeks, or

* 'Medical Gazette,' vol. i. pp. 710 and 756.

mouths, up to the limit of two years. *Average.*—In cases that prove fatal in 24 hours, about 10 hours.

Mortality.—Almost all infants and young children. In adults, two-thirds of the cases.*

Treatment.—That already described at p. 405.

Sulphuric acid has been injected into the vagina as an abortive; and into the rectum by mistake for a clyster; and it is used to disfigure the face and injure the dress. The local treatment of parts thus injured consists in the use of a solution of carbonate of potash or soda till effervescence ceases; followed by that appropriate to burns.

II. NITRIC ACID (*Aqua Fortis, Red Spirit of Nitre*).

This acid is much less in use as a poison than sulphuric acid, but much more than hydrochloric acid.

It may present itself for analysis, as—1. *The strong acid.* 2. *The dilute acid.* 3. *In stains on cloth.* 4. *In organic mixtures.*

1. *Strong Nitric Acid.*

The commercial acid varies in tint from a deep orange to a light yellow; gives out orange-coloured acid fumes; produces dry yellow stains in woollen tissues, and corrodes them, and causes similar stains in other articles of dress and in the nails, skin, and other tissues. The stains assume a bright orange tint when touched with an alkali. It dissolves copper with brisk effervescence and escape of ruddy acid fumes, a greenish liquid remaining. With morphia, the acid strikes a rich orange colour, effervesces, and gives off orange fumes; and with brucia a blood-red.

* The following are the results of several cases reported in the English and 'oreign Journals:—

Of 36 cases (the majority females)—26 were fatal (all the children and 18 dults), and 10 recovered (all adults).

Of 31 cases—20 were suicidal, 3 homicidal (all young children), and 8 accidental (2 of them children).

Among adults, both in accidental and suicidal poisoning, there was 1 recoery to 2 deaths.

Of the 26 fatal cases, 10 lasted a day or less; 6 more than a day and less ıan a week; 3 less than a fortnight; 1 from a fortnight to three weeks; 1 ore than three weeks; and 5 extended from five to forty-five weeks.

The *least* duration in 5 children was three and a half hours, the *greatest* ree days. In 20 adults the *least* was also three and a half hours, the *eatest* forty-five weeks.

The *average* in all surviving a day or less, was ten hours—of all surviving a eek or less, thirty-two hours.

The recoveries are stated to have taken place in from 6 to 23 days.

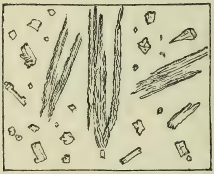
Perforation of the stomach took place in 8 cases out of 21 in which the postortem appearances are described.

For references to cases see former editions of this work.

2. *Dilute Nitric Acid.*

An acid liquid, with a characteristic odour, which reddens lit mus, and is not precipitated by nitrate of baryta or nitrate c silver. From the absence of precipitate with these reagents i may be inferred that the acid is neither sulphuric nor hydro chloric, nor any of the common vegetable acids. This presump tion is converted into certainty by th following tests—*a*. When boiled wit copper filings (provided the acid be no very dilute) the characteristic orang fumes are given off. *b*. If carbonate c potash is added to the liquid till efferves cence ceases, and a piece of filtering pape is dipped into the liquid and dried, it burn like touch-paper. *c*. On slowly evaporat ing the liquid, it yields crystals of nitrat of potash, of the form annexed.

Fig. 48.



Solution 1 in 100.

The crystals of nitrate of potash so obtained, yield the follow ing reactions:—*a*. Ignited on charcoal, they burn with deflagra tion. *b*. On adding strong sulphuric acid, a colourless vapou with the peculiar odour of nitric acid is given off. *c*. Drop fragment of the salt into a test-tube, add a few drops of distille water, then a drop of strong sulphuric acid; drop in a fragmer of copper: the characteristic ruddy fumes are given off. *d*. Procee as in *c*, and add one or two drops of strong hydrochloric acid: th resulting liquid dissolves gold leaf. The following tests are bes applied on a slab of white porcelain:—*e*. Moisten a crystal of the sa with distilled water, add a drop of pure concentrated sulphuric acic and dissolve by the heat of a spirit-lamp, allow the liquor to cool, an introduce a fragment of green sulphate of iron; a dark green rin changing to brown, will form round the crystal. *f*. Proceed as i *e*, and substitute a fragment of morphia. It strikes a rich orang colour, and yields a yellow liquid. *g*. Proceed as in *e*, and subst tute a fragment of brucia. It strikes a blood-red. *h*. Proceed in *e*, and add a fragment of narcotine. A reddish-brown colour produced, changing with a gentle heat to deep blood-red.*

* The following is an excellent test for any nitrate. Place in a test-tu a few drops of sulphuric acid, and add a little distilled water: then a fra ment of pyrogallic acid. Allow a few drops of strong sulphuric acid trickle down the side of the tube, and subside to the bottom. Add a f crystals of common salt, and when the effervesence ceases, drop in the crys of the nitrate. The acid at the bottom of the tube puts on an intense pur hue, which may extend to the rest of the liquid (Horsley, confirmed Wormley).

3. *Stains on Cloth.*

Boil the fragment of cloth in a little distilled water. The presence of an acid will be indicated by test-paper; that of nitric acid by the appearance of the stain. Neutralize with carbonate of potash, and filter. The dry filter burns like touch-paper. Evaporate the liquid, collect and examine the crystals, and apply the brucia test, and if possible the other tests in succession.

To distinguish stains of nitric acid from those caused by iodine or by bile, test with a weak solution of caustic potash. The indelible nitric acid stain assumes a clear orange tint; that caused by iodine immediately disappears; the bile-stain is unchanged.

4. *Organic Mixtures.*

If the liquid is viscid, dilute with distilled water, boil, and filter. If it has an acid reaction, neutralize with carbonate of potash, crystallize, and apply the tests just described.

If antidotes, such as chalk or magnesia, have been given, the liquid, instead of having an acid reaction, may be neutral or feebly alkaline. In this case, also, the filtered liquid is to be treated with carbonate of potash: soluble nitrate of potash will be formed, and insoluble carbonate of lime or magnesia thrown down. This being separated by fresh filtration, the filtered liquid is evaporated, and the crystalline residue tested for nitrate of potash.

When the quantity of acid in the organic liquid is very small, it may be removed from the vessel containing it by means of a rough syphon formed of filtering paper (Christison).

Mucous membrane acted on by the acid, may be treated as fragments of cloth.

In the case of nitric as of sulphuric acid, the post-mortem appearances are so characteristic as to render chemical analysis unnecessary.

Quantitative analysis.—To the nitrate of potash add strong sulphuric acid; dissolve the sulphate, calcine it, wash with alcohol to remove free acid, and evaporate to dryness. For 100 grains of the dry sulphate allow about 82 of the strong acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described (p. 403). A miliary rash, with intolerable itching, was present in one case on the sixth day.

Diagnosis.—The yellow stains on the skin, and the dry yellow corrosions on the dress, are characteristic of this acid. The

discovery of these stains on the person and dress of an accused person has led to his conviction.

Post-mortem appearances.—Those already described (p. 404). The colour of the mucous membrane yellow, or green in parts of the stomach and intestines containing bile. The corrosion less and perforation more rare than in the case of sulphuric acid.

Fatal dose.—Two drachms (Taylor). In infants less. Recovery has taken place after half an ounce,* or more.

Fatal period (*shortest*).—In the adult, an hour and three quarters; in the infant a few minutes. *Average.*—Less than twenty-four hours; but life may be prolonged to several days, weeks, or months.

Mortality.—About half the cases.

Treatment.—As for the mineral acids generally (p. 405).†

Nitric acid has been poured into the ear, and caused sloughing, abundant hæmorrhage, paralysis jactitans, extreme debility, and death in about thirteen weeks.‡

The orange fumes (nitrous acid gas) given off when nitric acid is poured upon copper or mercury, are largely produced in some processes of the arts, such as water-gilding and brass-button making. They irritate the eyes and lungs, and give rise to a troublesome cough, renewed by each repetition of the process; and at length becoming habitual. In more than one instance it has proved fatal in periods varying from twenty-seven hours to two days.§ The *symptoms* are burning heat in the throat; tightness at the chest and pit of the stomach; extreme distension and acute pain of the abdomen; nausea and vomiting; purging of a yellow matter; scanty secretion of urine and dysuria; cough, at first dry, then attended by scanty orange expectoration, with extreme dyspnœa, and feeling of impending suffocation; transient delirium; extreme debility; inexpressible anxiety; and death after convulsions. The *post-mortem appearances* consist in signs of acute inflammation and its consequences in the air-passages and lungs, and in the alimentary canal, engorgement of the lungs and heart with black liquid blood, distension of the stomach and intestines with gas, and a yellow colour of the contents of the air-passages and alimentary canal. Manufacturers who produce these irritating fumes should be required to conduct them into the nearest chimney.

The binoxide or deutoxide of nitrogen gives rise to these orange

* 'Lancet,' April, 1870 (Adams).

† For cases of poisoning by nitric acid, refer to 'Guy's Hospital Reports,' vol. xvii. p. 223 (Stevenson): 'Glasgow Med. Journ.,' May, 1872 (Dougall).

‡ 'Medical Gazette,' March, 1830.

§ See 'Lancet,' April, 1854: 'Chemical News,' March, 1863.

fumes by combining with air in the lungs. Sir H. Davy suffered very severely when he tried to inhale the binoxide.

III. HYDROCHLORIC ACID (*Muriatic Acid, Spirit of Salt*).

Though this acid is somewhat largely employed in the arts, it is not often used as a poison. It may have to be examined as—1. *The strong acid.* 2. *The dilute acid.* 3. *In stains on cloth.* 4. *In organic mixtures.*

1. *Strong Hydrochloric Acid.*

The acid of commerce is of a yellow colour, fuming in moist air, and yielding dense white vapours with ammonia. It produces a dry green stain on black cloth, but does not corrode it; or the stain is first red and then green. It is distinguished from sulphuric acid by its colour, and from nitric acid by the absence of orange fumes when poured on copper. When boiled with peroxide of manganese, chlorine is given off, known as such by its colour, odour, and bleaching properties.

2. *Dilute Hydrochloric Acid.*

The liquid is proved to contain an acid by litmus paper. The nitric acid and nitrate of baryta test causes no precipitate. It is probable, therefore, that the acid is either nitric or hydrochloric. If a solution of nitrate of silver yields a dense white precipitate insoluble in nitric acid, and in caustic potash, but very soluble in ammonia; which, when dried and heated fuses into a yellow liquid cooling to a soft horny mass, the acid is certainly hydrochloric.

As a chloride (such as common salt) with a free acid would have an acid reaction, and yield the same white precipitate with nitrate of silver, a drop of the liquid should be evaporated, when, if there is a crystalline residue, the acid should be distilled over, and the crystalline residue examined by the microscope, and tested.

3. *Stains on Cloth.*

Boil the stained cloth in distilled water, filter, test with nitrate of silver, and identify the precipitate as above. Examine, at the same time, an unstained portion of the same cloth.

4. *Organic Mixtures.*

Most organic liquids contain hydrochloric acid free or combined and most organic matters yield a precipitate with nitrate of silver. In the contents of the stomach, the acid may either exist in the free state, yielding a strong acid reaction, or it may be combined with an antidote, the liquid being neutral.

If the liquid has a strong *acid* reaction, we distil it at a low temperature, by immersing the retort in a boiling solution of chloride of calcium (two parts to one of water), the distillation being repeated by adding distilled water to the dry residue. The liquid in the receiver may be treated as pure dilute acid.

The detection of a minute quantity of free hydrochloric acid in the contents of the stomach does not prove its exhibition as a poison, for the gastric juice itself contains a minute proportion (1 part in 1500) of the free acid. But when the acid is found in appreciable quantity in the stomach of one in whom the symptoms and the post-mortem appearances were such as a mineral acid would produce, the cause of death admits of no doubt.

If the organic liquid is neutral, it may either contain no hydrochloric acid, or the acid may be combined with an antidote—magnesia, lime, soda, or potash. In this case we evaporate to dryness and calcine, dissolve the residue, and test the solution with nitrate of silver.

If the residue consist of common salt, it may have resulted from the administration of carbonate of soda as an antidote, or it may have formed part of the food. In this case also the chemical analysis must be confirmed by the symptoms and post-mortem appearances, and the stains which we may discover on the clothes.

Quantitative Analysis.—Use for this purpose the dried precipitated chloride of silver, of which 100 grains are equivalent to 69 grains of liquid hydrochloric acid.

Symptoms.—Those already described (p. 403).

Post-mortem appearances.—Those already described (p. 404). In a suicidal case, in which a large quantity of the strong acid proved fatal in less than twenty-four hours, the epithelium of the throat and gullet was destroyed in patches, and the stomach contained a large quantity of black grumous matter adhering to the surface. The preparation (presented by Mr. Bowman), with a drawing of the gullet and stomach, is in the Museum at King's College. As the appearances in this case, especially the shrivelled and worm-eaten aspect of the gullet, bear a very near resemblance to those present in cases of poisoning by sulphuric acid (see Roupell's Plates) and in one case of poisoning by oxalic acid

which came under my notice, I append three woodcuts, which, even in the absence of colours, convey a clear idea of the actual appearances (G.). Fig. 49 shows the corrugated and worm-

Fig. 49.

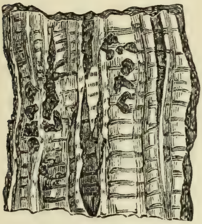
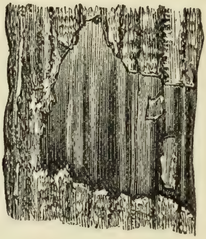


Fig. 50.



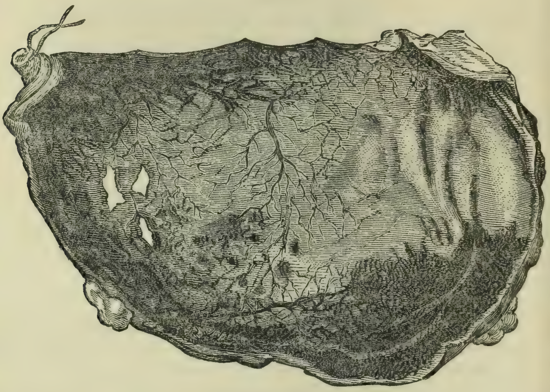
eaten appearance of the gullet; fig. 50 a portion of the gullet from which a large patch of epithelium has been removed, and fig. 51 the appearance of the stomach with its black grumous contents and vessels injected with black blood.

Fig. 51.

That undue importance, as a sign of corrosive poisoning, may not attach to the injection of the vessels of the stomach with black blood, or to the removal of portions of the lining membrane, I append an engraving (fig. 52), about one-fourth the natural size of the stomach of a female prisoner, who died from pulmonary consumption. It is taken from a drawing made while the stomach was fresh. The black granular appearance of portions of the stomach, the fine black injection of the vessels, the deep-red vertical streaks and irregular spots, with the three abraded patches, are remarkable illustrations of the effects of acid secretions of the stomach before and after death. The absence of such appearances in the gullet as are shown above, and of the grumous matters just described, with the absence of characteristic marks on the lips, mouth, and tongue, on the skin, and on the clothes, would prevent us from attributing such appearances to poisoning. In those rare cases in which the corrosive acid, being rapidly swallowed affects the stomach only, we should expect more marked appearances of corrosion in that organ, together with characteristic grumous matter.

The lining membrane of the stomach and intestines sometime has a yellow tint, or it is green from the action of the acid on the bile. No case of perforation has yet been reported; but in

Fig. 52.



a case of poisoning by a large dose of the dilute acid reported by Puchelt of Heidelberg, the entire stomach is stated to have been destroyed, and rejected by vomiting.

Fatal dose.—Dr. George Johnson relates a case of fatal poisoning by a tea-spoonful (ʒj) in a girl 15 years of age.

Shortest fatal period.—Five hours and a half. *Average.*—About twenty-four hours.

Treatment.—That of poisoning by the other mineral acids (p. 405).*

Hydrochhloric acid, combined with tincture of iron and corrosive sublimate, is the mixture used for browning gun-barrels. It is a highly poisonous liquid; and has been taken as a poison in one case. (Med. Gaz., Nov. 1839.)

Nitric acid mixed with sulphuric, (*aqua reginæ*) and with muriatic acid (*aqua regia*), are used in the arts, the one to separate silver from plated articles, and in the manufacture of collodion, the other to dissolve gold and platinum.

* For cases consult 'Bull. Gén. de Thérapeut.' 1871, p. 364 (Paul); 'Archiv. d. Heilk.,' 1872, p. 213 (Nager), and Dr. George Johnson's case cited above. ('Brit. Med. Journ.' March, 1871.)

II. THE ALKALIES AND THEIR CARBONATES.

These poisons share with the preceding group of irritants, the mineral acids, the property of destroying the animal tissues, without giving rise to specific remote effects: and of acting as corrosives when swallowed in a concentrated form (in substance, or strong solution).

The alkalies and their carbonates, in common with the alkaline earths, are distinguished from one class of metals by the negative effect of sulphide of ammonium; from another class by the negative effect of hydrosulphuric acid, and of sulphide of ammonium. They resemble the alkaline earths in having an alkaline reaction; but they differ from them in yielding no precipitate with carbonate of ammonia.

Though they are in common use for household purposes, or as medicines, they are seldom taken as poisons.

I. POTASH AND CARBONATE OF POTASH.

Caustic Potash, as used in the laboratory, is in the form of greyish masses, presenting an imperfect crystalline texture. It is soapy to the touch, acrid to the taste, highly deliquescent, fusible by heat, rapidly absorbs carbonic acid from the air, and is very soluble in water. When fused in small cylindrical moulds, it is the *potassa fusa* of the shops.

In solution as *liquor potassæ* it has a strong alkaline reaction; changes the colour of black cloth to brown; is not precipitated by carbonic or sulphuric acid, but yields with a solution of bichloride of platinum a yellow precipitate.

The *carbonate of potash, bicarbonate of potash*, or *salt of tartar*, is sold by oilmen in two forms. 1. As a mottled deliquescent mass—grey, yellow, brown, and black—with a soapy feel, urinous taste, and strong alkaline reaction. In this form it is known as *Potash* or *Potashes*, and is used chiefly for cleaning oil lamps. 2. In small white grains, or as a white semi-crystalline mass (*Pearlash*) having similar detergent properties, and used for washing and other cleansing purposes.

We may have to examine and identify these salts—1. *In substance.* 2. *In solution.* 3. *In organic mixtures.*

1. *In Substance.*

Potash (or potashes) is readily recognised by the physical properties just described. The white carbonate resembles in appearance carbonate of soda, and many other white powders. It has an alkaline reaction, effervesces and gives out carbonic acid when

treated by acids, imparts a violet tint to the deoxidizing flame of the blowpipe, and is very soluble.

2. *In Solution.*

A solution of carbonate of potash evaporated on platinum foil leaves a white deposit not dissipated by heat, and thus distinguished from the salts of ammonia : it has an alkaline reaction ; it yields a yellow precipitate with a solution of bichloride of platinum, resembling the salts of ammonia, but differing from those of soda ; it gives, with a solution of tartaric acid, a white precipitate of bitartrate of potash, which is promoted by agitation and by friction with a glass rod.

3. *In Organic Mixtures.*

If an organic liquid has a strong alkaline reaction, there is a presumption in favour of one of the substances contained in this chapter. By diluting and filtering the liquid and applying trial tests, we can ascertain which it is. The process for carbonate of potash consists in evaporating the organic matter to dryness, incinerating the residue, treating the ash with distilled water, and applying to the solution the tests just enumerated.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—When a strong solution of the poison is taken, there is an acrid burning taste in the act of swallowing, followed immediately by burning in the throat and gullet ; and this after a short interval by acute pain and great tenderness in the pit of the stomach, and frequent vomiting of a tenacious bloody mucus, of brown grumous matter, or of flakes of epithelium. Violent colic pains, with tension and tenderness of the abdomen follow, with purging of stringy mucus mixed with blood. There is much difficulty in swallowing, and sometimes hoarseness of the voice, and cough. In fatal cases, death takes place from collapse, or after prolonged sufferings from increasing difficulty in swallowing, constant vomiting of blood, bloody stools and tenesmus. In chronic cases the patient dies from starvation, brought on by stricture of the œsophagus.

Post-mortem appearances.—The lining membrane of the throat and gullet is softened and corroded; the œsophagus and stomach are inflamed, with abrasion and ulceration of the lining membrane, and dark spots or patches caused by extravasated blood. Sometimes the inflammation extends to the intestines and to the larynx or lungs (Nager). In chronic cases,

large portions of epithelium and mucous membrane are found removed, and the gullet and stomach are contracted. Perforation has not taken place in any of the recorded cases, but abscess followed by perforation of the œsophagus has been reported (Leischmann).

Fatal quantity.—Half an ounce.

Fatal period.—Shortest, three hours. *Average,* in acute cases, within twenty-four hours. In chronic cases, the fatal event may be delayed for days, weeks, months, or even years.

Treatment.—As an antidote, vinegar, largely diluted with water, or lemon-juice and water; acidulated demulcent drinks, and the juice of oranges and ripe fruits, followed by almond or olive oil. Inflammation may be met by ice in substance, or cold liquids; pain by preparations of opium; and collapse by stimulants. The stomach-pump should not be used.

II. SODA AND CARBONATE OF SODA.

Caustic soda has no medico-legal interest. *Carbonate of soda* is sold by oilmen for cleansing purposes, in two forms, as *soda* and *best soda*—the soda in a dirty crystalline mass, the best soda in masses of a purer white. Carbonate of soda may have to be identified in substance, in solution, and in organic mixtures.

1. *In Substance.*

Carbonate of soda has an alkaline reaction; effervesces and gives out carbonic acid when treated with an acid; readily crystalizes; is efflorescent; and imparts a yellow tint to the flame of the blowpipe.

2. *In Solution.*

Carbonate of soda differs from carbonate of potash by yielding no precipitate with bichloride of platinum, or with tartaric acid; while it gives with antimoniate of potash a white crystalline precipitate. The forms of the salts of the two alkalies also differ. When converted into nitrate by dilute nitric acid, soda crystallizes as rhombic plates, and potash as prisms.

3. *In Organic Mixtures.*

The process is the same as for carbonate of potash.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms, Post-mortem Appearances, and Treatment.—Those of poisoning by carbonate of potash: the symptoms less severe, and the appearances less marked.

III. AMMONIA AND CARBONATE OF AMMONIA.

Gaseous ammonia, dissolved in water, as the *liquor ammoniæ* or combined with carbonic acid as the *sesquicarbonate*, is largely used in medicine and the arts, and occasionally taken as a poison generally by accident. The incautious use of the vapour, to rouse patients from fainting fits, has also caused death by suffocation or inflammation of the air-passages.

The vapour of ammonia is readily recognised by its pungent odour, and by the change it produces in vegetable colours being dissipated by heat. The *sesquicarbonate* (hartshorn, volatile salt or smelling salts) has also a pungent odour, and is distinguished from the carbonates of potash and soda by being completely dissipated by heat; and from liquid ammonia by effervescing with an acid, and being precipitated white by the salts of lime.

Ammonia is set free from its salts when they are heated with liquid potassæ, the vapour being identified by its odour alkaline reaction, and the dense fumes formed with hydrochloric acid. Ammonia in *organic mixtures* must first be separated by distillation and then identified by its appropriate tests, of which the most delicate is Nessler's reagent. It yields a reddish-brown colour with traces of ammonia.

Symptoms.—These, as far as they are due to contact, are the same as those caused by potash and soda, and their carbonates; but from its extreme volatility it gains access to the air-passages and has thus proved fatal in so short a time as *four minutes.*

Post-mortem Appearances.—Signs of violent inflammation in the alimentary canal with separation of the epithelium of the mouth, and inflammatory appearances in the air-passages.

Fatal Dose.—One drachm of the strong Liq. Ammoniæ has proved fatal.* A case of death by 30 grammes, and another by 50 grammes, have been reported.†

Fatal Period.—From a few minutes to several hours (3, 4, 11).

Treatment.—Vinegar and water as an antidote, and the after treatment proper to the class of irritants.

* 'Guy's Hospital Reports,' v. xvii. p. 225 (Stevenson

† 'Jour. de Chem. Méd.,' May and July, 1868.

CHAPTER V.

IRRITANTS.

SALTS OF THE ALKALIES AND EARTHS.

THE carbonates of potash, soda, and ammonia, have been already treated of (p. 417). For binoxalate of potash, see oxalic acid; for iodide of potassium, see iodine. The poisons, therefore, that remain are:—The Nitrate, Sulphate and Bitartrate of Potash; the Sulphate of Alumina and Potash; Sulphide of Potassium; the Chlorides of Sodium, Lime, Soda and Potash; and the Salts of Baryta.

The nitrate, sulphate, and bitartrate of potash, the sulphate of alumina and potash, and the chloride of sodium, act as poisons only in large doses. As they are not deemed poisonous, they have been given to discharge worms or to procure abortion. Besides their local irritant action, the salts of potash would seem from experimental researches to have a paralysing effect on the heart and nerve centres (Traube, Guttmann, &c.). The sulphide of potassium, combining the irritant action of the base with the narcotic action of the sulphuretted hydrogen gas, is an active and fatal poison.

I. NITRATE OF POTASH (*Nitre, Saltpetre, Sal Prunelle*).

Poisoning with nitre is generally accidental, being mistaken for sulphate of soda or sulphate of magnesia.

Properties.—It is sold as colourless or nearly colourless crystals, or as crystalline masses; and in white spherical or circular cakes (sal prunelle). It has a salt cool taste, and the familiar property of causing matters with which it is mixed to deflagrate.

Tests.—See nitric acid (p. 409).

Symptoms.—Nitre has been taken in doses of a scruple, two or three scruples, and even half an ounce, without injurious effects; and in doses of one or two ounces has acted only as a strong emetic or purgative. But in several instances doses of an ounce and upwards have produced symptoms of acute irritant poisoning, with profuse discharges of blood by vomiting and purging, and bloody urine; and extreme prostration, accompanied or followed in some cases by convulsions, slight trismus, tetanus, and stupor, loss of speech, sensation, and voluntary motion, illusions of the senses and other nervous symptoms. In one case chorea of two months' duration.

Fatal Dose.—One ounce has proved fatal. A case of 25 grammes (about 375 grains) in a case reported by Chevallier. On the other hand, a case is on record of recovery after 4 ounces taken by mistake for sulphate of magnesia.

Fatal Period.—Death has taken place in *three* hours.

Post-mortem Appearances.—Acute inflammation in the stomach with black patches resembling gangrene; and in one case a small opening. Acute inflammation of the small intestines.

Treatment.—Vomiting, if absent, to be promoted by emetics followed by the free use of diluents and cold drinks: or the stomach-pump may be used. If nervous symptoms are present sedatives; if collapse, stimulants.

II. SULPHATE OF POTASH (*Sal de Duobus, Sal Polychrest*).

This salt in large doses has proved fatal. Ten drachms given in divided doses, to a French lady within a week of her confinement were fatal in two hours, with the symptoms and post-mortem appearances of irritant poisoning. An ounce and a half taken by a suicide caused marked appearances of irritation in the stomach and small intestines (Letheby.)

Tests.—The salt is readily identified by nitrate of baryta, as a test for the acid, and bichloride of platinum, as a test for the base.

Treatment.—As for nitrate of potash.

III. BITARTRATE OF POTASH (*Cream of Tartar, Argol*).

This salt is poisonous in such doses as two ounces and upwards. It has proved fatal to an adult male in forty-eight hours, with the symptoms and appearances of irritant poisoning. It is a sparingly soluble white powder, converted by heat into carbon and carbonate of potash, effervescing with acids. The solution has a feeble acid reaction. The base may be identified by bichloride of platinum. It may be obtained as a sediment from organic liquids. The *treatment* is by copious demulcents, and by remedies appropriate to the symptoms present. A dilute solution of the bicarbonate of potash may be given with advantage. It reduces the bitartrate to the harmless purgative, the neutral tartrate.

IV. SULPHATE OF ALUMINA AND POTASH (*Alum*).

This substance is not often taken as a poison.

Properties.—It is found in commerce as a colourless crystalline mass, or calcined, as a white mass or powder; or as iron-alum. It is intensely sour, and yields an acid solution, readily distinguished from dilute free acids by evaporation. A drop of the

solution evaporated on a slip of glass, leaves a beautiful compound crystal, consisting of straight parallel columns crossed at right angles by short lines, and surrounded by rectangular forms, blended with regular octahedra. From saturated or strong solutions the crystals are deposited either as octahedra or as cubes, and large masses of such crystals, either colourless or coloured, are familiar objects in the shops.

Tests.—The sulphuric acid may be detected by the solution of nitrate of baryta; the alumina is thrown down by liq. potassæ, as a white precipitate, soluble in an excess of the precipitant; and the potash may be detected by the chloride of platinum.

Symptoms.—Those of simple irritant poisoning (p. 380).

Treatment.—That of simple irritant poisoning. After emptying the stomach by the stomach-pump or by emetics, lime-water may be given with advantage.

V. SULPHIDE OF POTASSIUM (*Liver of Sulphur*).

The alkaline sulphides are active poisons, containing an irritant base with a narcotic gas.

Properties.—Liver of sulphur is found in the shops in dirty-green masses, or in powder of the same colour. It yields a yellow solution, and has a strong odour of sulphuretted hydrogen.

Tests.—On adding an acid the gas is disengaged, and blackens paper moistened with acetate of lead.

Symptoms.—Those of acute irritant poisoning, with convulsions, or stupor. The breath and the discharged matters have the odour of the gas. Death may occur in a quarter of an hour.

Post-mortem Appearances.—Redness of the stomach and duodenum, with deposit of sulphur. The surface of the body very livid. The lungs gorged with dark blood.

Treatment.—After dilute solutions of chloride of soda or lime (bleaching liquids), the treatment of irritant poisoning.

VI. CHLORIDE OF SODIUM (*Common Salt*).

Properties and Tests.—The solution of the salt yields on evaporation cubic crystals. The acid is detected by the solution of nitrate of silver; and the base by the negative reaction with the bichloride of platinum.

Symptoms.—Those of irritant poisoning (p. 380).

Treatment.—As for nitrate of potash (p. 422).

VII. CHLORIDES OF LIME, SODA, AND POTASH (*Bleaching Powders and Liquids*).

The chloride or hypochlorite of lime (common bleaching

powder); of soda (Labarraque's or Fincham's liquid); and of potash (Eau de Javelle), are all poisonous.

Properties.—These substances and solutions yield chlorine spontaneously, or on adding an acid; and they have a strong odour of the gas; and powerful bleaching properties.

The symptoms, post-mortem appearances, and treatment, would be those proper to the class of irritants.

VIII. SALTS OF BARYTA.

Properties.—The chloride of barium crystallizes irregularly in tables; is permanent in the air, soluble in water, and has an acrid taste. The carbonate is a fine white powder, insoluble in water, but soluble with effervescence in dilute acids, and readily decomposed by the free acids of the stomach.

Tests.—Baryta is thrown down from its solutions as a white precipitate by carbonate of potash, and as an insoluble white sulphate by sulphuric acid or the alkaline sulphates. Oxalic acid does not precipitate baryta from dilute solutions. The acids in combination with the base are distinguished, carbonic acid by effervescing with dilute acids; hydrochloric acid by nitrate of silver; nitric acid by precipitating the base with sulphate of potash, when nitre will remain in solution; and acetic acid by the odour of the vapour disengaged on adding dilute sulphuric acid.

Symptoms.—Those of irritant poisoning (p. 380), with violent cramps and convulsions, headache, excessive debility, dimness of sight and double vision, noises in the ears and violent beating at the heart.

The constitutional symptoms are due chiefly to the specific action of barium. The salts of barium have been shown by the researches of Mickwitz* to be cardiac poisons, causing stoppage of the heart in the contracted state.

Post-mortem Appearances.—Those of irritant poisoning (p. 382). In one case, fatal in two hours, the stomach was perforated.

Fatal Dose.—This is uncertain; but in a case reported by Tidy,† "green fire" given by mistake for flowers of sulphur, in quantity equivalent to somewhat more than a quarter of an ounce of the nitrate, proved fatal in 6½ hours.

Treatment.—The free use of the sulphate of soda or of magnesia as an antidote, emetics, and the stomach-pump. The after treatment is that proper to the irritants as a class. The heart may be stimulated to action by the movements of artificial respiration.

* Ziemssen's Cyclopædia, vol. xvii. (Trans. Toxicology.)
† 'Med. Press and Circular,' 1868, p. 447.

CHAPTER VI.

IRRITANT GASES.

1. Nitrous-acid Gas. (See p. 412.) 2. Sulphurous-acid Gas. 3. Hydrochloric-acid Gas. 4. Chlorine. 5. Ammonia. (See p. 420.)

The irritant gases have the common property of irritating and inflaming the eyes, throat, and whole extent of the air-passages, and in a concentrated form may cause fatal spasm of the glottis.

2. *Sulphurous-acid Gas.*—This gas is one of the products of the combustion of common coal, and contributes to the fatal result when coal is burnt in close apartments. It is also the chief cause of the irritating gusts which issue from the baker's oven, and contributes to produce the diseases of the chest to which the London bakers are peculiarly liable. For an account of the effects of sulphurous acid on those exposed to its influence, see Hirt, 'Krankheiten der Arbeiter,' part ii. p. 68.

3. *Hydrochloric-acid Gas.* — Hydrochloric-acid gas is very soluble in water, constituting the ordinary hydrochloric acid. The gas is set free in several processes in the arts and manufactures, more especialy in alkali works, and in potteries. Special legislation (The Alkali Act, 1863–4) exists against nuisances arising from the escape of large proportions of this gas into the atmosphere.

It is an intensely irritating gas, and prejudicial both to vegetable and animal life. Plants are injuriously affected and even killed by so small a proportion as 1 in 20,000 (Experiments of Christison and Turner) of the atmosphere. Small animals die in 3 or 4 hours, with symptoms indicative of lung affection, in an atmosphere containing 1 in 1,500 (Woodman and Tidy). The presence of hydrochloric-acid gas in the atmosphere is easily detected by exposing a drop of nitrate of silver on a slide: chloride of silver is formed, soluble in ammonia.

4. *Chlorine.*—This gas is largely used in bleaching, and, in the sick room, as a disinfectant. It produces violent irritation in the eyes, nostrils, air-passages, and throat. In a case cited by Christison, great relief was obtained by the inhalation of a small quantity of sulphuretted-hydrogen gas.

From information collected by Christison, it appears that men who are in the habit of inhaling air impregnated with chlorine become gradually accustomed to its use, though they suffer from dyspeptic complaints and acidity, and lose flesh; but nevertheless many of them attain to an advanced age. Most of them suffer from loss of smell (Hirt).

CHAPTER VII.

IRRITANTS.

PHOSPHORUS AND IODINE.

THESE poisons, as well as the preparations and compounds of most of the metallic poisons, give rise to remote effects not to be explained by the intensity of their local action. They may, therefore, be distinguished as *specific irritants*. But it is not deemed necessary to place the word "specific" at the head of this and the following chapters.

I. PHOSPHORUS.*

Properties.—It is usually found in the shops as long, small white, translucent cylinders, preserved in water, having the consistence and flexibility of wax, and a crystalline fracture. It is insoluble in water, but soluble in oils, alcohol, ether, and chloroform and remarkably so in bisulphide of carbon. After being kept some time in water it becomes covered with a yellowish-white coating.† When exposed to the air it gives off white vapours of phosphorous and phosphoric acids, and if heated or rubbed burns with a yellow flame, and emits dense vapours. It is luminous in the dark, and has the taste and odour of garlic. A paste consisting of flour sugar, oil, lard, or butter, and phosphorus, sometimes coloured with Prussian-blue, is sold as a poison for rats; and when mixed with nitre or chlorate of potash, gum, sand, and red lead, or other colouring matter, is used to tip lucifer matches. It has been given as a medicine in over-doses (Pil. Phosph., Ol. Phosph.) is very often taken in France, and sometimes in England, as it exists on lucifer matches; and has been given in substances and liquids of strong colour and flavour as a poison, or as an aphrodisiac.

Symptoms.—Poisoning by phosphorus is characterized by the variety of its symptoms, and often by their obscure and insidious character. It may occasion three well-defined groups of symptoms—*a. Irritant; b. Nervous; c. Hæmorrhagic.*

* In consequence of the frequent use of this substance in France, where it heads the list of poisons, and is given or taken twice as often as arsenic itself, it takes up nearly a tenth part of the work of Tardieu and Roussin.

† Yellow phosphorus subjected to a temperature of 240° C. in an atmosphere which does not act chemically on it (hydrogen or carbonic acid) is transformed into red or amorphous phosphorus. This is less inflammable than the yellow form, is not soluble in bisulphide of carbon, nor is it poisonous. It is largely used in the manufacture of "safety matches."

a. In the act of swallowing the poison a disagreeable taste and odour are often perceived, compared to garlic or burning sulphur. There is heat and pain in the throat, swelling of the tongue, and sometimes pain in the pit of the stomach, with discomfort, excitement, and nausea, followed often after a considerable interval by vomiting of matters mucous or bilious, rarely bloody; sometimes shining in the dark. Vomiting, when it occurs, affords relief, but it is often absent. Colic pains and diarrhœa, with some tenderness of the belly, sometimes follow. The countenance undergoes little change of expression, and the mind is intact. At the end of twenty-four or thirty-six hours the vomitings cease, the patient goes about as usual, complaining of wandering pains in the limbs and loins. The pulse is small, soft, and slow. This treacherous calm may last for two, three, or four days, or even more, and when the patient seems to have recovered, he may die suddenly without presenting any new symptoms. But generally, on the second or third day, jaundice shows itself with headache and sleeplessness, and retention of urine, which, when drawn off by the catheter, is found tinged with bile, and perhaps albuminous. Vomitings also occur from time to time, and painful, sometimes involuntary, discharges from the bowels. Acute delirium, followed by fatal coma lasting from six to twelve hours terminates the case. In many young infants, vomiting, followed by somnolence and convulsions, are the leading symptoms, and death takes place in from four hours to two days.

b. In this form the symptoms in the throat and stomach are attended by creeping sensations in the limbs, painful cramps, and repeated faintings, with extreme prostration and somnolence, but no fever, and no venereal excitement. The skin is dry, yellow, and marked by erythematous spots. About the fifth or sixth day, sometimes later, acute delirium suddenly breaks out, with rigid contraction of the jaw, and convulsions, followed by coma, and death in from a week to a fortnight, rarely later.

c. The symptoms set in as in the previous varieties, but the matters vomited often consist of pure blood, and are succeeded by bloody diarrhœa and tenesmus. The liver is swollen and painful; the heart's beats are feeble; and the weakness extreme. After some days the symptoms improve, but the colic pains continue, and some discharge of blood by stool. At the end of three weeks or a month, discharges of blood occur from the stomach, lungs, nose, ears, womb, and bladder; and bloody spots appear on the surface, and blend on the skin and in the eye with the yellow colour of jaundice. This state of things may continue

as long even as five months. Meanwhile the debility increases and the patient growing more and more anæmic and cachecti may die at the end of as many as eight months, with the nervou symptoms just described. When the poison does not prove fatal, it may leave behind it extreme debility, and partial paralysis—in one case by M. Caussé, incurable palsy of both hands.

Post-mortem Appearances.—The contents of the alimentary canal may be found phosphorescent; and when lucifer matches are taken, small fragments of deal, specks of sulphur, or of vermillion or other colouring matter adhere to the coats of the gullet, stomach, or intestine, or are found among their contents. The mucous membrane of the stomach and intestines is inflamed and softened, and marked by petechial spots or erosions. The mesenteric glands are swollen and softened. Occasionally perforation of the coats of the viscera takes place. The internal appearances are often such as occur in the worst forms of sea-scurvy—bloody spots in every organ and tissue, bloody serum in the cavities, blood in the intestinal canal, and in the bladder. The skin has a yellow tint, and is frequently marked with petechiæ. The blood coagulates imperfectly.

One of the most marked effects of poisoning by phosphorus is the fatty degeneration which it causes in the muscles generally, the heart, glands of the stomach, and kidneys, and especially in the liver. The heart and muscles are yellowish, soft, and easily broken down. The muscular fibres are filled with fat globules. The glandular epithelium of the gastric follicles, and of the cortical substance of the kidneys are filled with fat granules. The liver is generally enlarged, doughy, and uniformly yellow in colour. The outlines of the acini, however, are distinct. The hepatic cells are filled with fat. According to Wagner, also, especially in chronic cases, there is interstitial hepatitis with hypertrophy of the interlobular connective tissue. Fatty degeneration of the arterioles and capillaries has also been described (Klebs).

Fatal Dose.—One grain or less.

Fatal Period.—In acute cases as little as four hours. In chronic cases, life may be prolonged for several months.

Diagnosis.—The fact of poisoning by phosphorus may be ascertained beyond doubt by closing the doors and windows and examining the mouth and nostrils, person and clothes of the patient, as well as the matters rejected from the stomach or bowels, or things on which they may have been discharged.

Poisoning by phosphorus resembles in many respects the disease known as acute yellow atrophy of the liver; by some even they

are regarded as identical. There are, however, certain points of difference. In acute yellow atrophy the marked signs of acute gastritis which in phosphorus poisoning precede the jaundice, are wanting; and cerebral symptoms are more predominant; and though in both conditions there is fatty degeneration of the liver and internal organs, in phosphorus poisoning the liver is usually found enlarged, and the lobules distinct; while in acute yellow atrophy the liver is greatly diminished in size, greasy on the surface, and with the lobules almost obliterated.

In acute yellow atrophy, leucin and tyrosin are found abundanty in the urine; while in phosphorus poisoning these products are rarely if ever found, their place being taken by certain peptone-like bodies along with sarcolactic acid. From the researches of Voit and Bauer (see 'Journal of the Chem. Soc.,' vol. xxiv. p. 946) it would appear, however, that there is no essential difference between the effects of phosphorus poisoning and acute yellow atrophy; the differences observable being due more to the fact that the changes take place more rapidly in acute yellow atrophy than in poisoning by phosphorus. The fatty degeneration caused by phosphorus is attributed to diminished oxidation of fat and increased transformation of the nitrogenous tissues.

Treatment.—Antidote.—The researches of Köhler, Vetter, and others, seem to prove that in oil of turpentine we possess an efficient antidote for phosphorus, provided it be given in time. There is some difference of opinion as to the kind of oil of turpentine which is most effectual. It would appear that oil of turpentine which has not been rectified, and which has become ozonized by long standing, is the best. Vetter recommends us to begin the treatment with an emetic of sulphate of copper (regarded as a powerful antidote by Bamberger, as forming an insoluble compound). After the action of the emetic, oil of turpentine is to be given in 40-minim doses, in mucilage, every 15 minutes for an hour. Next day, magnesia should be given in mucilaginous drinks, and fats generally withheld. The rest of the treatment will vary with the symptoms present.

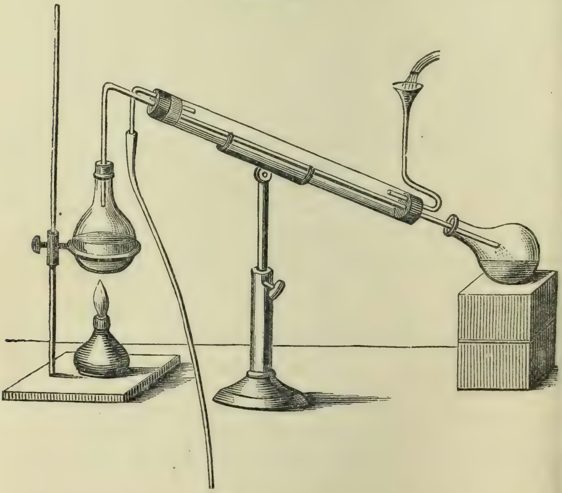
Detection of Phosphorus.—The characteristic odour of phosphorus may often be perceived in the contents of the stomach. If phosphorus has been taken in substance, such as heads of matches, it will be seen on inspection. It may be separated as a solid sediment, which will become luminous, or burn, on being heated. If we do not find any phosphorus in substance, the stomach, spread out on a plate, taken into a dark room and warmed, may become luminous, at the same time that the characteristic odour is given out. Putrefaction does not destroy the luminosity; but turpentine, ether, alcohol, and ammonia conceal

it. Or, we may agitate the organic matter with bisulphide of carbon, which on evaporation may leave globules of phosphorus that will inflame on the application of a hot wire.

Before resorting to other methods, we may apply Scherer's trial test. It consists in suspending in the mouth of the flask containing the matter supposed to be impregnated with phosphorus, a strip of filtering paper soaked in a solution of nitrate of silver. On warming the flask, if phosphorus be present, the paper will be blackened by the reduction of the silver and formation of phosphide. But as sulphuretted hydrogen produces the same effect, it is well to suspend with the nitrate of silver paper a slip saturated with acetate of lead. If the silver paper is blackened, and the lead paper not, phosphorus is present.

Mitscherlich's Method.—This is a most delicate test, and can detect 1 of phosphorus in 100,000. The luminosity, which

Fig. 53.



is its special feature, is however obscured by the vapour of alcohol, ether, turpentine, and ammonia. The matters supposed to contain phosphorus are to be diluted if necessary with water, acidulated with tartaric or sulphuric acid, and placed in a flask which may be heated over a naked flame, or, better, in a chloride of calcium bath. The vapours are to be conducted through a tube

cooled after the manner indicated in the accompanying figure. This process must be carried on in the dark; if phosphorus is present the vapours, when they reach the cool part of the apparatus form a flickering luminous ring.

The distillate in the receiver may contain globules of phosphorus along with phosphorous acid.

This process, after the luminosity has been demonstrated, may be modified by distilling in an atmosphere of carbonic acid, easily effected by connecting the distillation flask with a carbonic acid apparatus.

If the distillate is received into nitrate of silver, a brownish-black precipitate of phosphide, of silver is thrown down.

This precipitate, or the distillate of Mitscherlich's process itself, is admirably adapted for testing by Blondlot's method described below. Or the distillate may be evaporated with nitric acid, or chlorine water, by which phosphoric acid will be formed. The presence of phosphoric acid is indicated by a yellow precipitate with molybdate of ammonia, and a crystalline (triple phosphate) precipitate with ammonia and magnesia mixture.

Blondlot's Method.—This is based on the fact discovered by Dussard, that phosphorus and its lower oxidation products combine with nascent hydrogen to form phosphuretted hydrogen, which burns with an emerald-green flame. This test requires an apparatus similar to that used in Marsh's process for the detection of arsenic. (See fig. 70, p. 447.) Hydrogen is generated with pure zinc and dilute sulphuric acid, and the fluid material supposed to contain phosphorus is then introduced through a funnel. If phosphorus is present, the gas issuing from the apparatus burns with an emerald-green flame. The nozzle should be made of platinum; copper especially must be avoided. A glass nozzle speedily becomes so hot that the flame, even though phosphorus be present, does not exhibit a green colour, but only the yellow of sodium. The green colour may be brought out in great brilliancy by shading the flame from the direct sunlight, and pressing on it with a cold porcelain lid. The presence of certain vapours, such as those of alcohol and ether, conceal the colour. Even sulphuretted hydrogen is said to do so. Blondlot, therefore, recommends that the gas should be made to pass into a vessel containing a solution of nitrate of silver. If phosphorus is present, a brownish black precipitate of silver in combination with it is thrown down. This is then to be introduced into a Marsh's apparatus, when the emerald-green colour will be obtained with great distinctness. As already stated, the distillate of Mitscherlich's process, or the precipitate which it causes in nitrate of silver, may be tested in this way.

Phosphorus can also be removed from matters containing it by heating them with pieces of sulphur. This was the method employed by Lipowitz, before that of Mitscherlich came into use.

All these methods aim at the discovery of phosphorus or it lowest oxidation products. The presence of phosphoric acid would be no proof that phosphorus had been taken as a poison for phosphoric acid is a normal constituent of the body, and o many articles of food.

Chronic Poisoning by Phosphorus.

The manufacturers of phosphorus, and the makers of congreve matches, of some kinds of vermin-paste, and of phosphor-bronze are more or less exposed to the vapours of phosphorus, and waste away under prolonged dyspepsia and diarrhœa, with hectic fever and lung affections. Workers in lucifer match manufacturies, and in those of phosphor-bronze (an alloy of copper, tin, and phosphorus) are specially liable to these attacks (Ziemssen's Cyclopædia).

Those engaged in these industries also suffer from a local periostitis, leading to caries of the teeth and necrosis of the jaw. It begins with aching in one of the teeth (commonly of the lower jaw), which ceases on extraction of the tooth. But the wound in the gum does not heal; offensive matter oozes from it; and after a time a portion of the alveolus becomes exposed. Sometimes this comes away, bringing with it one or two of the adjoining teeth, and the disease is for the time arrested. More frequently, however, the disease spreads, more bone becomes denuded, the gums grow spongy and retreat from the alveoli, the teeth get loose and fall out, the fœtid discharge becomes more copious, and the disease spreads to the adjoining soft parts. At the end of six months, a year, two years, or more, the patient sinks from some exhausting disease promoted by the poisoning, or, having lost by degrees a half, or even the whole of the upper or lower jaw, the patient recovers subject only to a shocking deformity.*

Prophylaxis.—Free ventilation and cleanliness are of the first importance. The diffusion of turpentine through the workshops, by exposing it in flat dishes, is also beneficial. The discovery of the important fact that red, amorphous, or allotropic phosphorus, though possessing the same chemical composition, is not poisonous, may lead to the disuse of common phosphorus for manufacturing purposes.

* For a full description of this curious and painful malady, and for suggestions for its prevention, consult Dr. Bristowe's Report on the manufactures in which phosphorus is produced or employed, and on the health of the persons engaged in them (Fifth Report of the Medical Officer of the Privy Council, 1862); also researches of Wagner, Virchow's 'Archiv,' vol. v. 1872.

II. IODINE.

Properties.—A scaly substance, not unlike iron filings; of a peculiar and disagreeable odour, yielding irritating violet fumes when heated, striking a fine blue with solutions of starch, and staining the skin and intestinal canal a yellowish brown, removed by liquor potassæ. It is found in the shops in substance; as a tincture; and as a compound solution with iodide of potassium for solvent. It is largely used as an external application and as an injection in cases of ovarian cyst, hydrocele, &c.

Symptoms.—A disagreeable acrid taste, with heat, dryness, and constriction in the throat, in the act of swallowing, followed by the symptoms of acute irritant poisoning (p. 381), and nervous symptoms, like those described below as following injection into cysts. The discharges, of a deep yellow tint, or dark blue if mixed with starch-containing food, are often bloody.

Fatal results have ensued from the injection of iodine into ovarian cysts. In a case related by Rose,* great prostration came on a few hours after the injection, with imperceptible pulse, though the heart beat strongly; and repeated painless vomiting, diarrhœa, and suppression of urine. Death occurred suddenly on the tenth day, the constitutional effects of iodine exanthems, coryza, &c., having manifested themselves.

In chronic poisoning, from the prolonged employment of preparations of iodine as medicine, added to intestinal irritation, there are catarrhal symptoms, emaciation, tremors, palpitation, gradual absorption of the testicles, mammæ, and other glandular structures, ptyalism, increase of most of the secretions, priapism, and enlargement and tenderness of the liver. These symptoms may follow small doses administered for a few days at a time.

Post-mortem Appearances.—Those of acute irritant poisoning, (p. 382) with corrosion and brownish discolorisation of the mucous membranes. Enlargement of the liver.

Fatal dose.—Twenty grains in a child, 60 in an adult.

Treatment.—After the stomach-pump, a weak solution of carbonate of soda, and diluents containing starch, such as arrow-root.

Iodine in Organic Mixtures.—The poison is readily identified by the characters above given. Bisulphide of carbon which dissolves it readily, yielding a pink solution, also separates it from some of its solutions, and deposits it again on evaporation.

IODIDE OF POTASSIUM (*Hydriodate of Potash*).

Properties.—A crystalline substance, having a peculiar faint odour; white when pure, permanent in the air, and very soluble

* Virchow's 'Archiv.' vol. xxxv. (Ziemssen's Cyclop.)

Fig. 54.

in water and alcohol: when impure, of a yellowis colour, and deliquescent. Crystals cubical (fig. 54).

Tests.—Strong nitric or sulphuric acid turns th crystals brown, and liberates the iodine, which, on ap plying heat, rises in violet vapours.

In Solution it reacts as follows:—Corrosive sublimate throw down a fine carmine-red iodide of mercury; acetate of lea the yellow iodide; the subnitrate of mercury, the yellow sub iodide, which changes to a dirty brown; sulphuric and nitri acids turn the solution brown; and, on adding starch, blue. Th base is detected by the bichloride of platinum.

In Organic Mixtures.—Transmit sulphuretted hydroge through the mixture to convert free iodine into hydriodic acid Expel the excess of gas, add potash in excess, filter, and evapo rate to dryness. Char the residue in a covered crucible, at a lo red heat; reduce it to powder, treat it with distilled water, an filter; concentrate by evaporation; and apply the test of starc and sulphuric acid. This method will detect minute quantitie of the poison.

Symptoms.—Small doses of iodide of potassium given as medicin sometimes act injuriously; alarming symptoms have been produce by a few doses of two or three grains, or a single dose of five grains But it is being constantly given in doses of five, ten, or mor grains three times a day to large numbers of patients with out any bad effects. The symptoms are vomiting and purging severe griping pains in the abdomen, watering at the nos and eyes, swelling of the face, headache, dryness of the throat intense thirst, difficulty of breathing, frequent pulse, and grea prostration. In less marked cases they are those of a severe cold Ptyalism is an occasional symptom. In one case, in which ascertained that no preparation of mercury had been given, al the characters of mercurial salivation were present (G.) Long continued administration causes the phenomena of iodism jus described.

Treatment.—After the removal of the poison by emetics, o the stomach-pump, diluents, and cooling drinks.

CHAPTER VIII.

METALLIC IRRITANTS.

[. ARSENIC. II. ANTIMONY. III. MERCURY. IV. LEAD. V. COPPER. VI. ZINC, TIN, SILVER, IRON, BISMUTH, AND CHROME.

I. ARSENIC AND ITS PREPARATIONS.

ARSENIC is by far the most important of the metallic poisons, vhether measured by the extent to which it is diffused, its many ipplications in medicine and the arts, or its use as a poison.

Arsenic and its compounds enter largely into the composition of the earth's crust, as metallic arsenic, arsenious acid, and the wo sulphides, realgar and orpiment; or as a constituent of several ores of iron, copper, silver, tin, zinc, nickel, and cobalt. Most of he arsenious acid of commerce is prepared from an arsenical sulhide of iron, known as mispickel, or arsenical pyrites; the rest rom the roasting of ores, chiefly of copper and cobalt. Arsenic ias accordingly been found in several soils, and in plants grown n them, and in some mineral waters and running streams.

Arsenious acid is largely diffused through the air surrounding ome smelting furnaces, and arsenic acid and the alkaline rsenates are used as mordants, in some dye-works to such an exent as to poison the streams into which they discharge their reuse; and even to taint the water-supply of towns.

As the iron pyrites, or *mundic*, largely used in the manufacure of oil of vitriol, contains arsenic, much of the sulphuric acid f commerce is tainted with it; and this being, in its turn, used i the manufacture of nitric, hydrochloric, and other volatile cids, of sulphate of soda, as a preliminary to the making of the irbonate, and for other purposes, many liquid and solid substances i common use in medicine and the arts are impregnated with rsenic. The two metals, zinc and copper, the two acids, the ilphuric and hydrochloric, and the sulphide of iron used in testig for arsenic, have all been found to contain it.

Arsenious acid, the most important compound of arsenic, i much employed in the arts. It is used in the manufacture o glass, to improve the quality of the "metal," and in making white enamel. Composition candles sometimes contain it. It is used to prevent "furring" in steam boilers. Shipbuilders mi it with tar to protect timber from worms. It is contained i liquids, powders, and papers for killing rats and vermin, flies an moths. Farmers use it to preserve grain for seed, and as an in gredient in dipping compounds for sheep. Grooms give it t horses to improve their coats, and there is no longer any doub that some Styrian peasants habitually take arsenious acid i quantities exceeding the smallest poisonous dose.*

The metal arsenic is mixed with lead in small shot.

Preparations of arsenic have been mixed by accident or desig with articles of confectionery: arsenious acid with lozenges, orpi ment in Bath buns, and Scheele's green with blancmange. Thi last, or an analogous preparation, is also very largely used in man ornamental arts; and arsenic in the preparation of some anilin dyes.

Medicines containing arsenic are prescribed for the cure of agu and intermittent disorders, and of obstinate diseases of the skin and white arsenic, subdivided by mixture with calomel or othe suitable vehicle, is applied externally in lupus and cancer.

Arsenious acid enters into two preparations in the Britis Pharmacopœia, the liquor arsenicalis, or Fowler's solution (gr. i in fl. ℥j), and the liquor arsenici hydrochloricus (gr. iv in fl. ℥j)

Arsenic acid enters into the ferri arsenias, the sodæ arsenias and the liquor sodæ arsenatis (gr. iv fl. ℥j).

The preparations of arsenic most interesting in a medico-lega point of view are, the white oxide or arsenious acid, the yello sulphide or orpiment, the green arsenite of copper, or Scheele' green, and the arsenite of potash contained in Fowler's solutio Of these the arsenious acid is by far the most important.

As all our processes of analysis include the production of th metal arsenic as a means of identification, some account must firs be given of its most important properties.

The *metal* arsenic is stated to sublime at 356° Fahr.; but have found that in small quantities it sublimes at 230° (G). Th

* Dr. Roscoe, in a paper read to the Manchester Philosophical Societ Oct. 30, 1860, brought forward conclusive evidence in support of this state ment, and well authenticated instances in which the poison was swallowed i doses of 4½ and 5½ grains; and Dr. Maclagan has more recently placed th fact beyond the reach of doubt. See his interesting and instructive paper i the 'Edinburgh Medical Journal,' vol. x. p. 200; and letter from Dr. Knap bearing witness to the swallowing of 7½ grains of arsenious acid, at p. 669.

sublimation gives rise to the odour of garlic. When the process is conducted in close vessels, in an atmosphere of carbonic acid, it settles on cooler surfaces unchanged; but when heated in the air, it is deposited as white oxide (arsenious acid), or as a mixture of the acid with the metal. In common with antimony, it combines with nascent hydrogen (arseniuretted hydrogen). This gas, when burned, gives up the pure metal to cooler surfaces; and it shares with several other metals the property of being reduced and deposited on copper boiled in an acid liquor containing any of its preparations.

All these properties of metallic arsenic are displayed in operations on the small scale with the spirit-lamp and reduction-tube. The vapour of the metal has the garlic odour: it is deposited as arsenious acid, when the tube contains atmospheric air; and as pure metal when it is filled with carbonic acid gas: it forms a shining metallic crust, or stain, on white porcelain when the burning jet of arseniuretted hydrogen is directed upon it from Marsh's apparatus; it leaves a similar stain in the tube through which the gas is being transmitted, when it is heated by the spirit-lamp; and it gives a metallic coating to copper foil boiled in liquids acidulated with hydrochloric acid, as in Reinsch's process. The vapour of the pure unmixed metal is deposited on cooled surfaces as minute globules, which shine by reflected light like those of mercury (fig. 55); but when there is enough air present to oxidize part of the vapour, the globules of metal are blended with the white powder or brilliant crystals of arsenious acid.*

Fig. 55.

ARSENIOUS ACID (*Oxide of Arsenic, Sesquioxide of Arsenic, White Oxide of Arsenic, White Arsenic, Arsenic.*†)

Arsenious acid forms a good illustration of the benefits conferred by judicious legislation: for whereas in the years 1837-38 it caused 185 deaths (being as many as those attributed to all the preparations of opium, and many more than those caused by all other poisons), since the Act of 1851 (14 Vict. cap. xiii.), which restricted the sale of arsenic, and prescribed its admixture with soot or indigo if sold in small quantities, poisoning by arsenious acid has become less frequent, both absolutely and relatively to other poisons. Prior to this wholesome act of legislation,

* Refer to a paper by Dr. Guy, 'On the Production and Identification of Crystals of Arsenious Acid and Crusts of Metallic Arsenic,' in Dr. Beale's 'Archives of Medicine,' No. 111, 1858.

† In some country places it is known as "Mercury!"

arsenious acid caused 34 in 100 of all the deaths by poison; soon after it, the proportion fell to 1 in 10. In France, arsenious acid takes higher rank as a poison.

This common use of arsenious acid as a poison will excite no surprise; for it is as white as flour, is tasteless or nearly so, may be mixed with articles of food without undergoing or causing any change, is very cheap, and, as already stated, is largely used for a great variety of purposes.

Arsenious acid is found in commerce as a cake, and as a white powder. The cake, when first sublimed, is nearly transparent, but in time becoming opaque in layers, resembles a white enamel with thin transparent striæ. The poison, in both these forms has well-marked physical and chemical properties.

Properties.—1. Sparingly soluble in water, hot or cold. 2. The solution has a very slight acid reaction. 3. In substance tasteless, but its solution or vapour has a very faint sweet taste.* 4. The aqueous solution slowly evaporated, deposits octahedral crystals. 5. Very soluble in ammonia and hydrochloric acid, and is deposited from these solutions also as octahedra. It is also soluble in carbonate of potash. 6. Combines with alkalies forming soluble arsenites.

Solubility.—An ounce of cold water dissolves from half a grain to a grain; an ounce of boiling water poured on the poison retains on cooling a grain and a quarter; and an ounce of water boiled for an hour on the powder, 12 grains. When organic matter is present, the poison is less soluble (Taylor).

Tests.—We may have to identify the poison—1. *In substance.* 2. *In solution.* 3. *In organic liquids.* 4. *In the fluids and solids of the body.*

1. *Arsenious Acid in Substance.*

a. Heated by the spirit-lamp on platinum foil, it sublimes unchanged, as a white vapour. *b.* Heated in a reduction-tube, it is deposited as an amorphous powder, or in octahedral crystals. *c.* Moistened by liquor potassæ it does not change colour. *d.* When moistened by sulphide of ammonium, there is no immediate change, but when the excess of ammonia evaporates, is dissipated by heat, or neutralized by acetic acid, a canary-coloured sulphide of arsenic remains. *e.* When arsenious acid mixed with charcoal is dropped

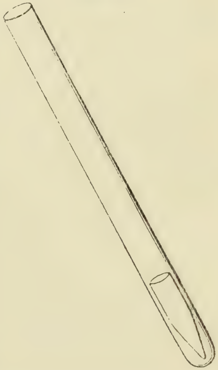
* A lad took from the mouth of a bottle as much arsenious acid as would cover a sixpence, and told me that it tasted like flour (G.) Otto Tachenius says, "that after many sublimations of arsenic, on opening the vessel, he sucked in so grateful and sweet a vapour, that he greatly admired it, having never experienced the like before."

into a reduction-tube and heated, the metal is reduced and volatilized, and deposited on the cooler part of the tube as a shining metallic crust. *f.* The sublimed metal has the garlic odour.

The two tests of sublimation and reduction must be more exactly described, and their results minutely examined.

Sublimation.—It has just been stated that arsenious acid dropped into a reduction-tube and heated by the flame of a spirit-lamp, yields a white vapour, which deposits on the cooler part of the tube an amorphous powder, or octahedral crystals. But as the crystals are characteristic of the poison, not the white amorphous deposit, it should be understood that in order to get these crystals, the white vapour must be received on a heated surface: on a cool surface it is deposited as an amorphous powder.

Fig. 56.



The process of sublimation is performed in a reduction-tube of about the size and length shown in fig. 56. After drying the tube by passing it repeatedly through the flame of the spirit-lamp, the arsenious acid, placed in a short tube of smaller size, is dropped in, and the flame applied, so as to envelop the lower third of the tube. By the time that the inner tube is so heated, as to sublime its contents, the temperature of the outer tube will be favourable to the deposit of distinct crystals.

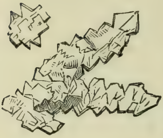
The subliming temperature of arsenious acid is variously stated at 370° to 400° Fahr., but I have ascertained, both by the method explained in the appendix and by placing fragments of the acid in small reduction-tubes in a sand-bath with the thermometer, that the real subliming point is at or about 280° Fahr. (G.).

The crystals of arsenious acid obtained by sublimation also result from the oxidation of the metal arsenic during the processes yet to be described; and as these crystals supply a very important means of identification, their shape and characteristic properties should be well understood.

The Crystals of Arsenious Acid are remarkable for brilliancy and permanence. They are almost always distinct and separate, except when superimposed; occasionally they are grouped in

rings; but they rarely form compound crystals of any definit shape. The crystals resembling those of alum depicted in fig. 57 are extremely uncommon. They were obtained by sublimatio in a small tube; and were probably firs dissolved in the moisture of the tube, an then deposited afresh.

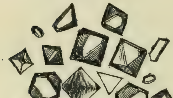
Fig. 57.



The prevailing form of crystal is the regular octahedron. The rhombic dodecahedron, rectangular prism, and plates of various shape and thickness, are less commor forms. For an account of the microscopic appearances of the entire crystals, the half crystals, the macles or twin crystals, and other exceptional forms, see Appendix.

Sometimes (probably from insufficient heat) all the crystals assume irregular and confused forms, and some few specimens consist almost wholly of the deep triangular plates which have been mistaken for *tetrahedra* (a form that never occurs).

Fig. 58.



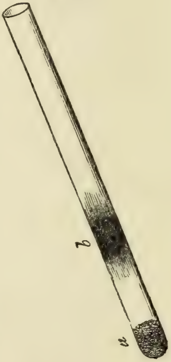
Some of the many forms which the crystals of arsenious acid assume are shown in fig. 58 as well as in figs. 62 and 63 where they are mixed with scatttered globules of metallic arsenic; also in the mixed crust of arsenious acid and metallic arsenic, as seen by reflected light in fig. 61.

Reduction.—Arsenious acid, well mixed with about four times its bulk of finely powdered recently ignited charcoal, is introduced into the tube, fig. 59 at *a*. The tube being held at an angle, and the flame of the spirit-lamp steadily applied at *a*, the metal rises in vapour, with the odour of garlic, and is deposited from a quarter to half-an inch above the mixture, as a dark brown or black ring, *b*. As the vapour quickly attracts oxygen from the air, it is readily oxidized: so that the ring is always a mixture, in variable proportions, of metallic arsenic and arsenious acid; the metal chiefly at the lower part of the ring looking like a mirror; the middle portion containing a large admixture of arsenious acid; and the upper part consisting almost wholly of it. By cautiously applying the flame of the lamp to the lower part of the ring, it may be condensed, and made more distinctly metallic; and by driving the crust repeatedly up and down the tube, it may be wholly converted into crystals of arsenious acid.

When this reduction is performed with proper precautions

(using a tube of green or German glass*), taking care that the mixture of arsenious acid and charcoal, and the tube itself, are free from moisture, so that the mixture may not be driven up into the tube; taking equal care to introduce it so as not to soil the tube; very satisfactory results are obtained. The mixed crusts cannot be mistaken for globules of mercury; nor for the crusts obtained by the same process from the white hydrated oxide of cadmium, as the anhydrous oxide of cadmium blended with the crust has a brown, green, or yellow colour.

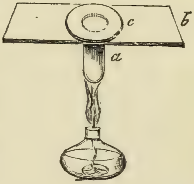
Fig. 59.



But as it might be alleged that the crust thus obtained does not present such distinct characters as to justify us in affirming that it is due to arsenic and to nothing else, we proceed to obtain crystals of arsenious acid in one of two ways. The sealed end of the tube containing the residue of the charcoal is drawn off, and the metallic crust driven up and down the tube till it is wholly changed into crystals of the oxide, or the sealed end of the tube, with the part free from deposit, is filed off, and the part containing the crust, being folded in stout paper, is broken into fragments, which are introduced into a second reduction-tube, and the crust converted into arsenious acid by heat.

But this mode of procuring a crust of metallic arsenic from arsenious acid and charcoal, and crystals of arsenious acid from the crust itself, is open to two classes of objections. The method itself is wanting in delicacy, and encumbered by precautions; and the results present themselves in a form very unfavourable for examination by the lens and microscope, especially when we are dealing with very small quantities of the metal or its oxide. These objections are obviated by the use of the simple apparatus shown in fig. 60.

Fig. 60.



* This is to guard against the possibility of the lead which enters into the composition of the more fusible English glass being reduced in the glass itself.

The mixture of arsenious acid and charcoal is first dropped into the clean and dry specimen-tube (a); supported in a circular hole in a porcelain or metal holder (b); the disk of glass (c) first dried in the flame of the spirit-lamp is placed over the mouth of the tube; and the point of the flame is then steadily applied to the bottom of the tube. The vapours of the metal when first disengaged combine with the oxygen of the air contained in the tube, and arsenious acid is re-formed, and deposited on the under surface of the glass disk, as an amorphous powder, or in glittering crystals, according to the temperature. The after-deposit may consist of globules of the metal.

The crust in this case, then, as in the usual process of reduction, is a mixture of metallic arsenic and arsenious acid, and when examined by the lens, or microscope, by reflected light has the appearance shown in fig. 61, where the sparkling triangular

Fig. 61.

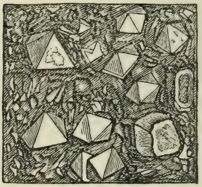
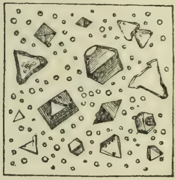


Fig. 62.



facettes of the octahedral crystals of arsenious acid are shown projecting through a layer of metal. A third form assumed by some of the thinner crusts, and by the circumference of the thicker

Fig. 63.

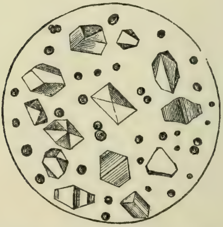
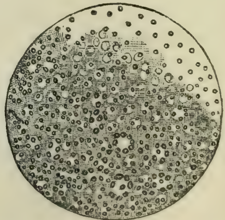


Fig. 64.



ones, consists of crystals of arsenious acid interspersed with distinct globules of metallic arsenic, as in figs. 62 and 63. The

thinnest crusts of all are iridescent, and may be resolved, under the higher powers of the microscope, into aggregates of small globules. Crusts of pure unmixed metal, presenting under the microscope the appearances shown in fig. 64, may be readily obtained by covering the mixture of arsenious acid and charcoal with a layer of bicarbonate of soda, so as to fill the tube with an atmosphere of carbonic acid gas. See also fig. 55, p. 437.

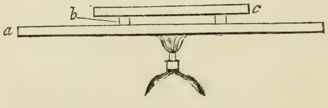
The appearances shown in figures 61, 62, and 63, prove conclusively the presence of arsenic. Those presented by the unmixed metal in fig. 64 are less conclusive, as the globules are sometimes not to be distinguished from those of mercury. Hence it may be necessary in the case of the purer crusts of arsenic, and expedient in other cases, to confirm the evidence afforded by the microscopic characters of the metallic or mixed crust, by converting the metal into arsenious acid. With this view cut the glass bearing the crust into narrow slips with a writing diamond, drop them into a specimen-tube (fig. 60), and treat them in the manner just described. The glass disk will be covered with glittering crystals, or with a mist which can be resolved, under the higher powers of the microscope, into groups of octahedra.

It may be well to state that the metals cadmium, selenium, and tellurium are also sublimed by the heat of a spirit-lamp; that selenium is deposited as globules, and tellurium sometimes converted into crystals of telluric acid. But crusts of selenium have the colour of port wine, the crystals of telluric acid are needles, and the metallic crusts of cadmium and tellurium are not globular.

There is still one method of procedure specially applicable to minute quantities of arsenious acid. If, on evaporating on a porcelain slab a drop of liquid supposed to hold arsenious acid in solution, a white amorphous, or obscure crystalline stain is left, we may test it in one of two ways.

1. By the simple process indicated in the accompanying figure. On heating the porcelain slab (*a*), a mist will settle on the heated superimposed disk of glass (*c*) resting on the ring (*b*), which, when examined by the microscope, will be found to consist of crystals of arsenious acid. In this way $\frac{1}{1000}$ grain arsenious acid may be identified without difficulty, and even $\frac{1}{5000}$ grain be found to yield characteristic results.

Fig. 65.



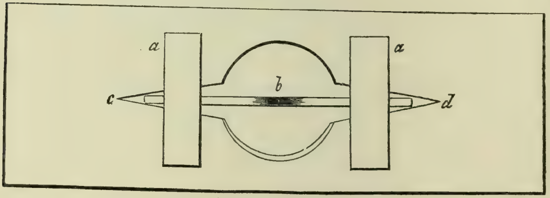
2. Take a fragment of microscopic glass, and mark it with a

writing diamond, so that when broken it may yield narrow slips. Place a drop of the solution on the glass, let it dry, and then

Fig. 66.

break the glass. Draw out a small tube of green glass *a á* into the form shown in fig. 66; dry the tube by passing it repeatedly through the flame of the spirit-lamp; introduce the slips of glass into the open end of the tube at *b*; seal the tube at *a*, and shake the slips down to the sealed end. Place the tube in a good side-light, and after heating the capillary portion, apply the flames of the lamp steadily at the end *a*. When the sublimate shows itself as at *c*, draw off and seal the capillary tube at *d d*, and mount it for the microscope as in fig. 67, which represents a card the size of

Fig. 67.



the common glass slide, with a central aperture enlarged by side cuts. The capillary tube, *c d*, rests on a perforated label gummed to the back of the card, and is confined to its place by the slips of gummed paper *a a*. Write the date and circumstances of the reduction on the card. As the sides of the capillary tube *c d* are very thin, they offer no impediment to the examination of the stain *b* with the higher powers of the microscope, especially if we employ a flattened glass tube instead of the usual round tube. The stain will be found to consist of crystals of arsenious acid. In this way such small quantities of the poison as the $\frac{1}{1000}$ grain may be detected with certainty, and less than $\frac{1}{5000}$ grain where the reduction is carefully and skilfully performed.

These two methods of procedure are equally applicable to the reduction of the metal: the first to the stain of metallic arsenic obtained by Marsh's method on the slab of white porcelain; the second to the mixture of arsenious acid and charcoal. By the first

method the stain will be sublimed and deposited as arsenious acid: by the second a mixed crust will be obtained consisting of metallic globules blended with crystals of arsenious acid.

2. *Arsenious Acid in Solution.*

There are several tests for arsenious acid in solution:—Three applied as liquid, and known as *liquid tests;* one as gas, distinguished as the *gaseous test;* a fifth is the well-known *Marsh's test;* and a sixth the now equally well-known test of *Reinsch.*

1. *The Liquid Tests.*—These are three in number:—the ammonio-nitrate of silver, the ammonio-sulphate of copper, and sulphuretted hydrogen water. *a.* Ammonio-nitrate of silver.* This throws down a rich yellow arsenite of silver, which, on exposure to light, changes to dingy brown. *b.* Ammonio-sulphate of copper† causes a precipitate of the bright green arsenite of copper (Scheele's green). *c.* Sulphuretted hydrogen water throws down the yellow sulphide of arsenic. The sulphide of ammonium produces no immediate effect, but after a long interval, or on the addition of a few drops of acetic acid, causes the same precipitate.

These tests are supposed to be applied in succession to a clear colourless liquid believed to contain arsenious acid, and so applied, are free from objection; but it should be understood that a solution of phosphoric acid yields with ammonio-nitrate of silver a yellow precipitate, as an alkaline phosphate does with the nitrate; and that a decoction of onions gives with the copper solution a green precipitate. As these liquids are only used as trial tests, or to prove that a white powder or colourless crystals obtained from the oxidation of a ring of metal really consist of arsenious acid, these facts do not constitute a valid objection.

Gaseous Test.—This test, too, is supposed to be applied to a clear colourless liquid. Having ascertained that it has no decided acid or alkaline reaction, we slightly acidulate with acetic acid, and transmit the sulphuretted hydrogen gas. If the liquid contains arsenious acid, it soon assumes a rich golden yellow tint. If the quantity of the poison is considerable, a precipitate of the same colour is formed; but, if small, it is not thrown down till the excess of gas has been expelled by heat, and the liquid has been left at rest for several hours. The only other substances which yield a yellow precipitate are the peroxides of tin and cadmium,

* Formed by adding liquor ammoniæ to a strong solution of nitrate of silver, till the brown oxide of silver at first thrown down is nearly redissolved.

† Formed by adding liquor ammoniæ to a solution of the sulphate of copper till the bluish-white hydrated oxide of copper is nearly redissolved.

both of rare occurrence, and easily distinguished. The sulphide of antimony is orange-coloured. The presumption, therefore, is strong in favour of arsenic, and may be converted into certainty by collecting and testing the precipitate, or by applying the ammonio-nitrate of silver and the ammonio-sulphate of copper to other portions of the same liquid.

The precipitated sulphide having been allowed to subside, is to be collected, washed, and dried, and submitted to a process of reduction differing from that for arsenious acid in the substitution for charcoal of a flux containing an alkali. That usually employed is the *black flux* formed by incinerating a mixture of one part of nitrate of potash with two of the bitartrate. But incinerated acetate of soda, or a mixture of one part of cyanide of potassium with three of carbonate of soda, previously well dried, is to be preferred, and used in the proportion of one of the sulphide to twelve of the flux. The metallic crust obtained by this process of reduction is a mixture of metallic arsenic, arsenious acid, and undecomposed sulphide.

In dealing with minute quantities of the sulphide, the capillary tube (fig. 66, p. 444) should be employed, followed, if the quantity be sufficient, by the method described at p. 443 (fig. 65).

The sulphides of cadmium and tin are thrown down immediately by sulphide of ammonium, but the sulphide of arsenic not till the ammonia has been dissipated, or neutralized by an acid. The sulphide of arsenic is very soluble in ammonia, those of cadmium and tin insoluble. The sulphide of arsenic yields a distinct metallic sublimate, while the sulphide of tin yields none, and the sulphide of cadmium gives the sublimate described at p. 443.

When the precipitated sulphide is not pure in colour or free from organic matter, it should be dissolved in ammonia, and again thrown down by hydrochloric acid.

The gaseous test, followed by the reduction of the metal from the sulphide, gives certain evidence of arsenic. It is unnecessary, though for medico-legal purposes desirable, to convert the sublimed metal into crystals of arsenious acid.

Marsh's Test.—This test was proposed by Mr. Marsh, of Woolwich, about the year 1835. He employed two forms of apparatus; the one (fig. 68) consisted of a tube bent in the shape of the letter J, the long leg being twice the length of the shorter one, and open, and the latter furnished with a stop-cock terminated by a nozzle with a minute bore. Hydrogen was generated in this apparatus by pure zinc, and dilute sulphuric acid, to which a portion of the liquid containing arsenic was added. When the

arseniuretted hydrogen had filled the smaller leg of the tube, the stop-cock was opened, and the jet of gas inflamed. On holding over the flame a piece of glass or porcelain, a distinct metallic ring was deposited upon it. For larger quantities of liquid Mr. Marsh used the apparatus depicted in fig. 69.* Many alterations and modifications of Marsh's apparatus have been since suggested, of which fig. 70 represents by far the most convenient form. It consists of a wide-mouthed bottle with a closely fitting cork, pierced for two tubes, of which the one, furnished with a funnel, dips beneath the liquid, the other bent nearly at right angles, but sloping slightly towards the bottle, descends a short distance into the vessel. This tube is furnished with a cork for the reception of a detached horizontal tube of glass free from lead, and drawn out into a point with a small aperture.

Fig. 68.

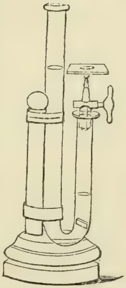


Fig. 69.

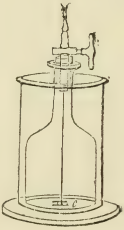
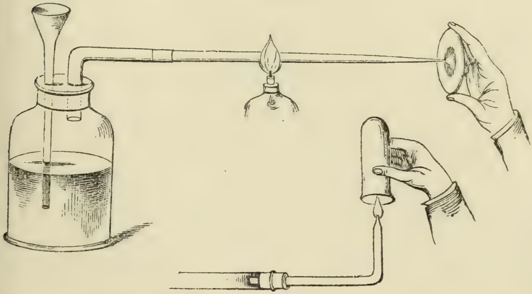


Fig. 70.



In this apparatus hydrogen is generated by pure zinc and dilute sulphuric acid, and the action is continued till the atmospheric air is completely expelled, and all risk of an explosion avoided. The flame of a spirit-lamp is then steadily applied for ten or fifteen minutes to the horizontal tube. If there is no

* For an account of the apparatus employed by Mr. Marsh, and the results obtained, refer to the 'Transactions of the Society of Arts,' vol. li. 1835-6.

deposit we conclude that the zinc and sulphuric acid do not themselves contain arsenic. Having ascertained this, we pour into the funnelled tube part of the liquid supposed to contain arsenious acid, and immediately reapply the spirit-lamp to the horizontal tube. If the liquid contain arsenious acid, a metallic deposit takes place in the tube half an inch or more from the part to which the flame is applied. The horizontal tube should be five or six inches long, so that we may obtain two such crusts at least. Having procured these, we light the hydrogen as it issues from the end of the tube, and obtain one or two deposits on slips of porcelain, and others on disks of crown glass. A very minute quantity of arsenic suffices for both these purposes. We may then continue to apply the flame of the lamp to the horizontal tube, till the absence of stain from a fragment of glass held before the jet proves that the metal is exhausted. Or the gas may be led into a solution of nitrate of silver. Metallic silver is thrown down, and arsenious acid with excess of nitrate of silver remains in solution. On the addition of ammonia the lemon yellow arsenite of silver is precipitated.

The evidence afforded by the stains may be confirmed by bending the horizontal tube at right angles and holding a wide test-tube over the flame (fig. 70). The tube will be coated with arsenious acid resulting from the oxidation of the metal, and to its contents, dissolved in a small quantity of distilled water, we may apply the liquid tests.

The round stains on the surface of porcelain may consist either of arsenic or antimony, and have the following distinctive properties:—

a. The arsenical stain has every variety of metallic lustre, from that of copper to that of steel, but it never wears the sooty appearance proper to most crusts of antimony. *b.* The arsenical stain is much more readily dissipated by the heat of the spirit-lamp, and gives out the garlic odour.* *c.* The two stains are characteristically affected by several liquid and gaseous reagents, from which we select three;—the first two as tests by simple solution, the last as a test by solution followed by a characteristic coloured residue.†

* This test may be applied as follows:—Procure a standard crust of arsenic and one of antimony on the ends of an oblong porcelain slab, then a stain at either end of the slab from the liquid under examination. Apply the flame of the spirit lamp steadily to the centre of the porcelain. The stains, if arsenical, will soon contract under the heat, and ultimately disappear, before the antimony stain shows any signs of being affected.

† The first of these tests was suggested by Bischoff, the second by Dr. Guy ('Medical Times,' July, 1847), the third also by Dr. Guy in a former edition of this work.

1. The arsenical stain is rapidly dissolved by a solution of the chloride of lime (bleaching liquid), which does not affect the antimonial stain. 2. The antimonial stain is less speedily, but at length completely, dissolved by a solution of the protochloride of tin, which does not dissolve the arsenical stain. 3. The antimonial stain is rapidly dissolved by the sulphide of ammonium; the arsenical stain slowly and imperfectly. The solution of the antimonial stain, when dry, leaves an orange-coloured spot of sulphide of antimony, while the imperfectly dissolved arsenical stain presents a light lemon-yellow spot of sulphide of arsenic mixed with portions of undissolved metal.

Should the stain contain both antimony and arsenic, the chloride of lime will dissolve out the arsenic, and leave the antimony. So, on the other hand, the protochloride of tin will dissolve the antimony, and leave the arsenic.

The arsenical stain, as it usually contains some arsenious acid, may be tested directly by the ammonio-nitrate of silver in the following simple way:—Add to the stain a drop of nitrate of silver solution, with a glass rod (slightly stirring), and then blow the vapour of ammonia upon it. The lemon-yellow arsenite of silver will be immediately formed.

The larger and thicker stains of arsenic may also be readily identified. Globules of metallic arsenic may be seen by the higher powers of the microscope in the stain; or the stain itself may be transferred from the slab of porcelain to a glass disk by the method described at p. 443, and illustrated in fig. 65. The glass disk will be found covered with octahedral crystals; or, if the cell is shallow, with globules of the metal, or the two combined.

The stains of antimony and arsenic in the tube also present remarkable differences. The antimony is deposited close to the point to which the heat is applied, and on both sides of the flame (A, fig. 71); the arsenic at some distance from it (B, fig. 72).

Fig. 71.

A

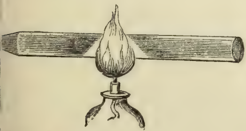
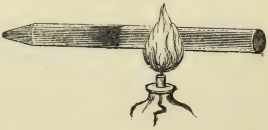


Fig. 72.

B.



When heated, the antimony volatilizes very slowly, the arsenic quickly; the arsenic has often a nut-brown or copper colour, the

antimony the lustre of tin. Of these properties the first and second are highly characteristic; but the colour of the crusts is less constant; for though antimony rarely presents the copper colour of arsenic, nor arsenic the tin-like lustre that belongs to most crusts of antimony, the two crusts may resemble each other in colour, though not in shape or position. The effect of heat is decisive; for while the antimony crust moves slowly under the flame of the spirit-lamp, and undergoes little change, the arsenic crust is easily dissipated, and readily converted into crystals of arsenious acid. The crusts of arsenic and antimony may also be distinguished by detaching the horizontal tube, transmitting dry sulphuretted hydrogen gas through it, and chasing the metal, by the flame of the lamp, in a direction opposite to the stream of gas The antimonial crust changes its place very slowly, and graduall assumes, but only in part, the characteristic orange hue of th sulphide; while the arsenic stain is readily driven from point to point as a light lemon-yellow crust of sulphide.

Some precautions are necessary in using Marsh's test. To guard against explosion, the gas should be generated freely a first, but less briskly when adding the suspected liquid; for th smallest addition of another metal occasions a violent extricatio of gas. The first violent action having subsided, the jet shoul be lighted; and the absence of arsenic (in other words the purit of the zinc and sulphuric acid) ascertained by repeatedly holdin a clean surface of porcelain to the jet, as well as by steadil applying the flame of the spirit-lamp to the horizontal tube fo several minutes. If there is no stain on the porcelain or in th tube, the suspected liquid may be added drop by drop, the flam being kept all the time steadily applied to the horizontal tub A few stains should also be obtained on porcelain and on glas If there should happen to be much froth, a small quantity spirits of wine may be poured into the funnelled tube.

Reinsch's Test.—Put the liquid containing arsenic into a tes tube, and add about the eighth of its bulk of pure hydrochlor acid, drop into the tube a narrow short slip of clean copper fo and heat the liquid to the boiling point. If the slip of copp is speedily tarnished by the liquid, other slips may be introduce one by one, until the copper retains its colour. The slips a then to be removed, washed in distilled water, and dried at a lo temperature. The metal arsenic will be found to form an iro grey coating, adherent if in small quantity, but readily separatin if more copious. A single slip if thickly coated (or several sli if merely stained) is then to be introduced into the capilla reduction-tube (fig. 66), with the precautions described at p. 44

Minute crystals of arsenious acid, readily identified under the microscope will be found in the capillary part of the tube. If characteristic results are obtained by this process, other slips may be similarly treated in the manner described at p. 441, and illustrated in fig. 60, or by the method figured and described in fig. 65, p. 443. The crystals of arsenious acid, being on a flat surface, can be readily examined by the microscope.

By either of these methods satisfactory results should be obtained with the $\frac{1}{1000}$ grain of arsenic, and in skilful and practised hands with the $\frac{1}{5000}$ grain.

Certain precautions must be taken in employing this test. As hydrochloric acid may contain arsenic, and as specimens of copper, even many of those thrown down by the electrotype process, also contain it, the copper must be first boiled in the dilute hydrochloric acid. If untarnished, the acid may be considered pure; and if the copper itself, when boiled in the acid liquor supposed to contain arsenic, is not dissolved, and does not impart a green colour to the liquid, the copper may be used with safety. It is only when the liquid which is being tested dissolves the copper, that the impurity of the metal can interfere with the result. In order, however, to guard against both fallacies and objections, a copper of ascertained purity should be used.

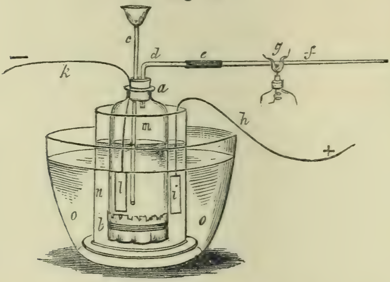
The process of sublimation which constitutes the second part of the test is necessary, because other metals as well as arsenic yield metallic deposits: solutions containing mercury and silver without boiling, and those containing antimony, bismuth, tin, and lead, on applying heat. Alkaline sulphides also tarnish the metal.

These metallic deposits differ in appearance; but not so as to dispense with the use of further tests.

Galvanic Test.—Professor Bloxam advocates the method of electrolysis as the least objectionable means of generating arseniuretted hydrogen and procuring crusts of metallic arsenic. He first made use of the simple modification of the J-tube fig. 68, p. 447, but afterwards preferred an apparatus of the form shown in the annexed engraving, in which *m* is a two-ounce bottle, the bottom of which is replaced by vegetable parchment *b*, secured by thin platinum wire. The cork *a*, carries a funnelled tube *c*, a small tube *d*, bent at right angles, and connected by a caoutchouc tube *e*, with a drawn-out reduction-tube *f*; and it is pierced by a platinum wire *k*, suspending a plate of platinum foil *l*. The wire is connected with the negative pole of a galvanic battery. The bottle is placed in a glass *n*, a little larger than itself, and into which the positive plate *i*, attached to the wire *h* of the battery is introduced. The apparatus stands in a larger vessel *o o*, filled with cold water.

An ounce of dilute sulphuric acid (1 acid to 3 water) is the poured into the bottle, the poles are connected with the batter

Fig. 73.



and hydrogen gas is generated till all fear of an explosion cease The shoulder of the reduction-tube at g having been heated t redness for fifteen minutes, to ascertain the purity of the acic the liquid to be tested is introduced through the funnelled tube Frothing is prevented by adding a drachm of alcohol. The met arsenic is reduced in the horizontal tube at g, as in the moder form of Marsh's apparatus.

This method supersedes the use of zinc in generating the ar seniuretted hydrogen, and thus excludes one possible source fallacy; and it is very delicate. It was successively applied in series of experiments with quantities of arsenious acid varyin from the $\frac{1}{100}$ to the $\frac{1}{1000}$ grain, a characteristic arsenical mirro the alliaceous odour, and a shining ring of crystals of arseniou acid being obtained in each instance.* It may be well to ad that in generating hydrogen in the ordinary form of Marsh's ap paratus, zinc may be replaced by magnesium, which is free fro the impurities sometimes found in zinc.

3. *Arsenious Acid in Organic Liquids.*

As arsenious acid is very insoluble in water, and still more so organic liquids, the poison may sometimes be obtained in a soli

* On the application of electrolysis to the detection of the poisono metals in mixtures containing organic matters. ('Quarterly Journal of th Chemical Society,' 1860.) For information concerning the fallacies th may attach to the processes of Marsh and Reinsch, consult this valuab paper: also one by Wm. Odling, M.D. on some failures of Marsh's proce for the detection of arsenic, and Dr. Taylor's 'Facts and Fallacies,' &c., i 'Guy's Hospital Reports,' 1860. See also a paper by Dr. Gamgee, 'Edi Med. Journ.' 1864.

form by diluting with distilled water, and allowing the powder to subside. It may also be found adhering to the mucous coat of the stomach, from which it may be detached. The solid arsenious acid obtained in these ways may be treated in the manner described at p. 438.

If there is no solid arsenious acid in the organic liquid, the poison may still be diffused through it or dissolved in it; in which case the liquid must be rendered slightly alkaline by liquor potassæ, and then carefully evaporated to dryness over a water-bath. By this means most of the organic matter is coagulated, so that, by boiling the residue in distilled water, a liquid is obtained which will pass the filter; and may be treated as arsenious acid in solution by any of the methods described at p. 445. This mode of procedure is to be preferred when time is no object, and there is reason to believe that the quantity of the poison is considerable. In other cases the process presently to be described must be employed. The solid matters that remain on the filter must be preserved, so that if we fail to procure evidence of arsenic from the filtered liquid, it may be treated by the methods now to be described as applicable to the solids and fluids of the body.

4. *Arsenious Acid in the Solids or Fluids of the Body.*

As there are cases of poisoning by arsenic in which the poison is entirely expelled during life, so that no trace of it can be found in the stomach after death, it is most important to be able to detect it in the fluids or solids to which it has been conveyed by absorption.

The destruction of the organic matter is to be effected with hydrochloric acid and chlorate of potash in the manner described previously (p. 400). In the case of arsenic it is advisable according to Fresenius and Bloxam to reduce the arsenic from the higher to the lower oxide by adding bisulphite of soda until the acid liquid smells strongly of sulphurous acid. When this is driven off, the liquid may be tested by the methods above described. The reduction to the lower oxide favours the precipitation by sulphuretted hydrogen. The precipitated sulphide is soluble in sulphide of ammonium, which also dissolves antimony and tin if present. To separate the arsenic from antimony or tin, as also to destroy any organic matter still remaining and interfering with the reduction and quantitative estimation, the solution in sulphide of ammonium should be evaporated, and fused, according to Meyer's method, with a mixture of carbonate and nitrate of soda. The organic matter is destroyed, and a fusate is left which con-

tains arsenate of soda; water dissolves the arsenate, while th antimoniate is insoluble, and oxide of tin, if present, is almos insoluble. To guard against any tin being in the solution, carboni acid should be passed through it. The solution of the arsenat filtered should be evaporated with sulphuric acid to drive off an nitric or nitrous acid, dissolved in water, and is then ready fo the various tests.

Arsenic may also be separated from organic substances by dis tilling them with hydrochloric acid, or with a mixture of sulphuri acid and chloride of sodium. A volatile chloride of arsenic i formed, which being condensed and collected in a receiver may b tested by the various methods described.

Quantitative Analysis.—The quantity of arsenious acid is bes determined by the use of the pure sulphide obtained from a measured portion of the filtered liquid; 100 grains of sulphid nearly correspond to 80 grains of arsenious acid.

When the body of a person supposed to have been poisoned by arsenic is disinterred for analysis, and the poison is detected in the stomach, in the solid textures, or in the fluids of the body, it is sometimes alleged that the arsenic contained in the surrounding soil was dissolved in water and conveyed into the body. To meet this allegation it may be necessary to analyse a portion of the soil. One or two pounds are first treated with boiling water, and the filtered liquid, reduced by evaporation, is tested by Reinsch's process. If this gives no indication of arsenic, the soil is treated with one part hydrochloric acid to ten of water. The dissolved lime and iron are thrown down by bicarbonate of potash added in excess, and the resulting liquid, filtered and reduced as before, is examined by Reinsch's test.

The following facts bearing on the detection of arsenic in the dead body require to be borne in mind:—

a. Arsenic may be detected in the dead body after such long periods as seven and ten years. *b.* Arsenious acid, usually found attached to the coats of the recent stomach as a white powder or paste, is converted into the yellow sulphide by the sulphuretted hydrogen generated by putrefaction. *c.* Preparations of arsenic preserve dead animal matter. *d.* There is good reason for believ-ing that Orfila was mistaken when he affirmed that arsenic is a natural constituent of the human body. *e.* Arsenic when con-tained in the soil is generally, if not always, an insoluble compound of iron or lime. *f.* Preparations of arsenic, whether taken in single large doses, or in repeated small ones, enter the blood; may be found in the textures and secretions; and are only slowly eliminated from the body. The limit usually stated for the

complete elimination of arsenic from the body is three weeks; but M. Bonjean has extended it to a month.*

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—In most cases the symptoms set in within an hour of the swallowing of the poison, with burning pain at the pit of the stomach increased by pressure, with nausea, and vomiting, renewed by the act of swallowing. The pain soon becomes more diffuse, and there is swelling and tenderness of the belly, with diarrhœa, tenesmus, and dysuria. After the setting in of vomiting, if not previously, there is a sense of constriction in the throat, with intense thirst, inflammation and smarting of the eyes, headache, violent palpitation, frequent pulse, quick catching respiration, extreme restlessness, great debility, cramps in the legs, and convulsive twitchings in the extremities. In most cases the mind is intact. When the poison is rapidly fatal, death commonly takes place by collapse, or by coma; in chronic cases the patient dies exhausted by the violence of the irritative fever, or after a long train of nervous symptoms terminated by convulsions. Patients who recover are either restored to perfect health, or they suffer from indigestion, from prolonged weakness or palsy of the limbs, or from epileptic fits. But cases of poisoning by arsenic present the greatest possible variety in the character, combination, and severity of the symptoms, and exceptions and anomalies of the most perplexing kind.

In one considerable class the symptoms are those just detailed in an aggravated form. The vomiting is incessant; the pain in the pit of the stomach most acute, and increased by the slightest pressure; the mouth, tongue, and throat are red, hot, and swollen; the eyes bloodshot; the countenance flushed; the thirst excessive; the diarrhœa profuse, and attended with tenesmus and discharges of blood; the belly acutely painful and tender, and much swollen; the urine suppressed or passed with pain and difficulty; the pulse full, quick, and frequent; and the respiration laborious; there is a sense of oppression at the heart with violent palpitation; intense headache, with giddiness, incessant restlessness, and severe cramps in the legs and arms, followed, if life is prolonged, by convulsions, tetanic spasms, epileptic fits, delirium, coma—a group of nervous symptoms varying with each case, and terminating in various ways, and at various intervals, in recovery or death.

In a second class, the symptoms are those of collapse. There

* Ranking's 'Half-Yearly Abstract,' vol. iii.

is little or no pain, vomiting, or diarrhœa; a cold and clammy skin; extreme prostration, a very frequent and almost imperceptible pulse, or one as low as thirty or forty beats in the minute. The mind, as in most cases of arsenical poisoning, is unimpaired, but there is some approach to coma, slight cramps or convulsions, and death without reaction, usually in four or five hours, rarely beyond twenty. Sometimes this state of collapse is accompanied by constant vomiting and profuse purging.

In a third class of cases the patient falls into a profound sleep, deepening into coma, and dies in a few hours without rallying. Such a case is reported by Mr. T. Wright, of Dublin. Death took place in four hours, and followed upon sound sleep; and after death there was no trace of inflammation of the mucous membrane of the stomach even in the spots covered with arsenic.*

In a fourth class, the symptoms so closely resemble those of English cholera as to avert suspicion from the minds even of intelligent and well-informed physicians. Such was the case of the Duke of Praslin.

All these varieties occur under large and small doses of the poison, and are not accounted for by the form or vehicle in which it is administered. The same dose administered in the same way may give rise to prolonged vomiting and purging in one man, to collapse in a second, to coma in a third, to violent irritative fever and severe nervous symptoms in a fourth; and these leading forms may even run into, and be blended with, each other.

Though these varieties cannot be completely explained, they become more intelligible when we reflect that the poison is an irritant to the alimentary canal, and, as such, gives rise to all the symptoms local and remote, which follow such irritation—pain and tenderness, vomiting and purging, cramps and spasms; that it is absorbed into, and circulated with the blood, and so develops its specific effects on the whole course of the alimentary mucous tract, not only reinforcing the direct effect of the poison in causing pain and tenderness, vomiting and purging, but superadding redness and smarting of the conjunctiva, intense thirst, palpitation and rapid pulse; that it affects the nervous system both by direct action on the parts with which it comes in contact, and by being circulated with the blood through the nervous centres, hence headache, delirium, convulsions, tetanic symptoms, epileptic fits, extreme weakness, and paralysis; and that, lastly, as it is being eliminated from the system by the secretions of the

* 'Lancet,' vol. xii. p. 194.

liver, kidneys, and skin, it gives rise in one person to jaundice, in another to dysuria (and even suppression of urine, with blood tainted with urea, and coma as a sequence), and in a third to painful cutaneous eruptions. Administered in large doses or to feeble persons, the first shock to the system might prove fatal, as in drinking cold water or in blows on the stomach.

As great importance attaches to poisoning by arsenic, and the character and grouping of the symptoms varies greatly in different cases, the following summary is here given of the symptoms *stated* to be present in 25 cases.

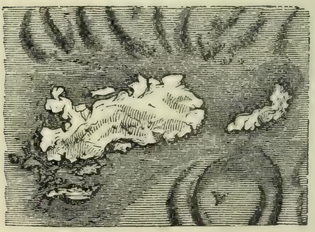
Alimentary Canal.—*Vomiting* in 23 cases, but in one not till artificially induced. (In a few cases, this, in common with every other marked symptom, has been absent.) The *vomited matters* consisted, in 3 cases, of blood; in 2, of mucus tinged with blood; in 1, of mucus only; in 1, of water containing arsenic; in 1, of bile, and in 1, of bile and fæces. (The vomited matters are sometimes described as yellow or brown.) *Diarrhœa* present in 11 cases, but absent in 4; in 7 cases excessive. The *matters passed by stool* consisted, in 3 cases of blood, and in 2 of a material closely resembling green paint. *Pain,* present in 19, and altogether absent in 1; in two instances it subsided after a short time, and it is stated not to have been increased by pressure in two instances. The *tongue and throat* sore, constricted, hot, painful and tense, in 9 cases. *Thirst,* present in 15 and absent in 2; in 13, described as intense. The *countenance* flushed and swollen in 7 cases; pale and anxious in 5; the facies Hippocratica present in 1. The *eyes* inflamed, swollen, or smarting in 7 cases. The *skin* hot and dry in 6 cases; covered with cold perspiration in 4; profusely perspiring, with petechiæ, in 3; universal desquamation in 1; covered with an eczematous eruption in 1. *Headache* in 9 cases, absent in 1; described as intense in 4. Violent *palpitation* in 2 cases. *Pulse* generally very frequent, but of variable character, ranging from 90 to 140, or more; in one case 30 to 49. Jaundice, suppression of urine, strangury, and salivation must be added to this list of symptoms. *Nervous symptoms.*—Extreme *restlessness* in 5 cases; extreme *debility* in 10; *coma* in 3; *delirium* in 3. The *mind* unimpaired in 6 cases; *cramps* in the legs in 9 cases, in 4 extending to the arms; *convulsions* in 6 cases; *paralysis* of tongue and gullet in 3; *tetanus* in 2; *chorea* in 1; *hysteria* in 1; *epilepsy* in 2. Tetanus, coma, and delirium successively in 2 cases. *Death* took place in 3 cases in the midst of convulsions, and in 1 after a horrible fit of convulsive laughter followed by rigid spasms of the whole body.

Locked jaw has been observed among the early symptoms—in one case so early as three-quarters of an hour (Orfila).*

The long persistence of nervous symptoms is well illustrated by the case of Mr. Gadsden, one of the victims of Eliza Fenning. He was seized with epilepsy on the first day; had four attacks on the second, then a fit every evening at the same hour, for fourteen successive evenings; then an interval of seven or eight days, followed by another relapse, and that by another interval of three weeks; at the end of three months the fit still recurred every twelve hours, or three or four times in two days; and he continued even after the lapse of two years, to be subject to frequent attacks. In the case of Helen Mitchell, there was extreme debility of the limbs for three months.

Post-mortem Appearances.—The stomach is the seat of acute inflammation spreading over the entire surface, or confined to the rugæ in well-defined patches, or streaks. Sometimes, in lieu of the bright tint of inflammation the membrane has the deep hue of congestion. When the poison is taken in substance, the most common and characteristic appearance is that of one or more patches, from the size of a shilling to that of a crown, consisting of a tough white or yellowish paste of arsenious acid mixed with coagulable lymph, firmly adherent to the inflamed mucous membrane, and forming so many centres of intense inflammation. White spots are also often found between the rugæ. The annexed engraving shows a group of such spots resting on an inflamed base, and surrounded by deep dusky red

Fig. 74.



* The reader is referred to the following cases:—Messrs. Turner and Mr. Gadsden, poisoned by Eliza Fenning, in Mr. Marshall's Remarks on Arsenic; those of the Mitchells, reported by Mr. Alexander Murray, in the 'Edin. Med. and Surg. Journal,' vol. xviii. p. 167, and three cases given by Mr. Alexander McLeod, in the same Journal, vol. xv. p. 533. These cases afford excellent illustrations of the nervous symptoms which follow poisoning by arsenic. Also 'Ed. Med. and Surg. Journal,' v. 389; liv. 106, 262; lvi. 295; lix. 250. 'Lancet,' July 21, 1827; Aug. 15, 1829; Oct. 31, 1829, vii. 254; Oct. 6, 1838; Nov. 3, 1838; and Nov. 24, 1838. 'Medical Gazette,' v. 411; ix. 895; xiv. 62; xv. 828; xix. 238; xx. 309. 'London Medical Review, iv. 188; xix. 288. 'Guy's Hospital Reports,' No. iv. 68; and subsequent volumes. See, also, 'Lancet,' 1866, ii. 336, for an account of a series of cases in which nervous symptoms were a marked feature.

streaks. Ulceration is comparatively rare, and perforation still less common. Gangrene also is a rare occurrence; but the dark swollen appearance produced by extravasation of blood into the submucous tissue is often met with. The stomach usually contains a brown grumous matter, occasionally tinged with blood; but sometimes the colour is yellow, from the partial conversion of the poison into sulphide; and the mucous coat has been found smeared as with yellow paint. The inflammation generally extends to the duodenum and commencement of the other small intestines, and occasionally affects the whole length of the intestinal canal, being most conspicuous in the lower bowel. The œsophagus, also, is sometimes the seat of inflammation, and in rare instances the mouth, tongue, fauces, and windpipe have been involved in the inflammatory action. The peritoneal covering of the stomach or of the entire abdomen is sometimes found in a state of inflammation, and the intestinal glands are swollen. Among occasional post-mortem appearances may be mentioned, inflammation of the bladder, livid spots on the skin, and congestion of the brain with serous effusion; but the most remarkable post-mortem appearance is the absence from the lining membrane of the stomach of all traces of inflammation, and of every other characteristic change. This anomaly is not due to death having taken place before inflammation could be set up; for well-marked inflammatory appearances have been present in the most rapidly-fatal cases.

Arsenic, like phosphorus, has been found, both by experiments on animals* and by clinical observation, to cause a fatty degeneration of the muscles and of various organs, especially the liver, the kidneys, and the glands of the stomach. A fact of more physiological than toxicological interest has likewise been pointed out by Saikowski—viz., that in animals poisoned by arsenic, artificial diabetes cannot be caused by the usual method.

Fortunately for the ends of justice, arsenic not only preserves the stomach when surrounding parts are in a state of advanced decay, but even the characteristic appearances of inflammation may be present after the body has been buried several months.

Fatal Dose.—In solution, as small a quantity as *two grains* may prove fatal. *Two grains and a half*, in two ounces of fly-water, killed a strong healthy girl, æt. 19, in 36 hours (Letheby). Much smaller quantities have given rise to alarming symptoms. On the other hand, recovery has taken place from doses of half an

* Virchow's 'Archiv.' xxxiv.

ounce, an ounce, and even an ounce and a half, of the poison in substance. These larger doses are often taken on a full stomach, and are promptly rejected with the food, or carried away by the brisk action of the bowels.

Fatal Period.—The poison has proved fatal in *two hours*, in three or four instances (one by Mr. Foster, of Huntingdon, and one by Mr. Macaulay, of Leicester), but Mr. Thompson communicated to Dr. Taylor a case fatal with tetanic symptoms in *twenty minutes*. On the other hand, cases may prove fatal after three, four, five, six, or seven days, or even as late as the second or third week, and from secondary symptoms, in two or three years. The average duration of fatal cases is 20 hours; but of those which terminate within 24 hours, less than 7 hours. As many as 85 in the 100 die within 24 hours. More than half the cases terminate within 6 hours, two-thirds within 8 hours, and more than three-fourths within 12 hours.*

Mortality.—About half the cases; fatal cases being to cases of recovery as 52 to 48.

Proportion of Suicidal, Homicidal, and Accidental Cases.—In 100 cases, about 46 are suicidal, 37 homicidal, and 8 accidental. This statement is based on 92 cases. The cases of suicide were equally divided between men and women.

Commencement of Symptoms.—In some instances, ten minutes after taking the poison; and they have been described as setting in immediately. But they may be delayed for several hours (in one case ten hours.) Sleep probably delays the operation of the poison.

Treatment.—As arsenious acid itself is a powerful emetic, it is sometimes (especially when swallowed with, or soon after a meal), completely rejected from the stomach. In other cases, on the exhibition of an emetic, or the free use of diluents, the contents of the stomach are discharged, and with them the poison. When, on the other hand, it is taken on an empty stomach, it attaches itself to the mucous coat, excites violent inflammation, and the formation of a tenacious secretion, which glues it to the surface, and protects it from the action both of emetics and antidotes. In the first class of cases, recovery is often attributed to some substance thought to possess the virtues of an antidote. Arsenic, also

* Of 41 cases which survived less than a day, 3 were fatal in 2 hours; 1 in 2 hours and a half; 1 in 3; 2 in 3 hours and a half; 8 in 4; 6 in 5; 6 in 6; 2 in 6 hours and a half; 1 in 7; 2 in 8; 2 in 9; 2 in 12; 1 in 15; 1 in 17; 1 in 21, and 1 in 24 hours. Of 7 which lasted more than a day, 1 was fatal in 36, and 2 in 48 hours; 1 in 3 days and a half; 1 in 4 days and a half; 1 in 6, and 1 in 7 days.

may occasion so free an evacuation of the bowels as to carry off the poison partly by this channel.

The first step in the treatment consists in removing the poison as promptly as possible from the stomach. If the stomach-pump is at hand it should be used without delay. If not, and the poison itself is acting freely as an emetic, vomiting should be promoted by copious draughts of warm milk and water, and tickling the throat with a feather. If the patient is not sick, emetics of ipecacuanha, mustard, or common salt, aided by similar copious draughts of warm milk and water, should be given. When the stomach has been emptied by these means, one of the antidotes mentioned below, milk, or milk beaten up with eggs, or a mixture of milk, lime water, and white of egg, should be given freely at short intervals.

The rest of the treatment will be determined by the symptoms which happen to be most urgent. Collapse must be met by stimulants, and nervous symptoms by anodynes. Tetanic spasms would be best relieved by chloroform. The intense thirst may be satiated with small quantities of iced water; the tenesmus and dysuria by injections of gruel containing laudanum; the diarrhœa, if ineffectual and painful, by castor oil mixed with milk. Antimony must not be given as an emetic; for the resemblance of the crusts of antimony to those of arsenic would give rise to an objection to the chemical evidence. The sulphates of zinc and copper, and antidotes containing iron ought also to be avoided, lest it should be alleged that arsenic existed in them as an impurity.

Antidotes.—Several preparations of iron, of which the hydrated sesquioxide is the best, the hydrated oxide of magnesia, calcined magnesia, and animal charcoal, have been recommended as antidotes for arsenious acid in solution. The hydrated sesquioxide of iron, formed by precipitating the tinctura ferri perchloriditis, of the shops with excess of ammonia, renders a solution of arsenious acid wholly or nearly inert, and some experiments on dogs made by Dr. W. Watt prove that, as an antidote for arsenious acid in solution, it is really efficient.* It should be freely given in the moist state. The dialyzed iron, now so common in medicine, may be substituted. The hydrated oxide of magnesia precipitated from a strong solution of the sulphate by liq. potassæ, and well washed, has been also shown to be effectual, and is free from objection should the patient die, and an analysis of the contents of the stomach be required.†

* Wormley's 'Micro-Chemistry of Poisons,' p. 247.

† See a paper by Chevallier ('Ann. d. Hygiène' xxx.) on the Efficacy of Iron and Magnesia in Poisoning by Arsenic. The iron seems to have proved most effectual.

When the poison is given in the solid form these antidotes are much less efficacious; and still less so when it adheres to the lining membrane.

While treating a case of poisoning by arsenious acid, or by other preparations of arsenic, it should be borne in mind that evidence of poisoning may be obtained by examining the urine, the serum from a blistered surface, or the blood, as well as from the matters vomited or passed from the bowels.

Arsenious acid has been introduced into the body otherwise than by the mouth. It has been inserted into the vagina, producing intense local inflammation, and the characteristic general symptoms of arsenical poisoning. It has been applied to the skin in the form of a mixed powder and of ointment, with similar local and constitutional results (especially in the hands of "cancer-doctors"); and it has been inhaled as vapour, and as arseniuretted hydrogen. The smoke of candles containing arsenic has also produced severe indisposition.

OTHER PREPARATIONS OF ARSENIC.

Arsenite of Potash.—The active principle of Fowler's solution: in which it may be readily detected by any of the methods described for arsenious acid.

Arsenic Acid.—This acid, though a powerful poison, is of no medico-legal interest except as being formed in some processes for detecting arsenious acid. It is a white deliquescent solid, not completely volatilized by heat, very soluble in water, and having a strong acid reaction. It yields a metallic sublimate when reduced with charcoal, and a metallic crust when treated by Marsh's or Reinsch's method; and gives a yellow precipitate with sulphuretted hydrogen, on boiling. It is precipitated a brown red by nitrate of silver, and by the ammonio-nitrate.

The salts of arsenic acid (arsenates) give the same reactions.

Arsenite of Copper (Scheele's Green).—This is a fine green powder, containing one part of arsenious acid to two of oxide of copper. It yields distinct crystals of arsenious acid when heated, and a residue of oxide of copper; and is soluble both in ammonia and in nitric acid.

Aceto-Arsenite of Copper.—This is a bright green powder known as mineral, Schweinfurt, Brunswick, or Vienna green, and in England as emerald green, or "emerald." It is largely used by paper-stainers, for fancy and for wall-papers, both alone to impart a full green colour, and mixed with oxide of zinc, porcelain powder, or whiting, to give more delicate tints of green. It is

also used to give a green colour to sweetmeats and confectionery, wafers, toys, and cages, cakes of water colour, oil colours, articles of dress, and papers used as wrappers for fruits and sweetmeats.

Tests.—The powder consists of arsenious acid 6 parts; oxide of copper 2 parts; and acetic acid 1 part. Arsenious acid therefore constitutes two-thirds of its bulk. It is readily identified by giving off when heated strong fumes of acetic acid and depositing crystals of arsenious acid, with a residue of oxide of copper. In papers and other matters coloured with emerald green, the poison is readily detected by scraping off the surface and subliming the powder thus detached : or, by dropping a fragment of the coloured material into a test-tube containing a weak solution of liquor ammoniæ. The material will be bleached; a blue solution will show the presence of copper; and if a fragment of nitrate of silver is dropped into it, a precipitate of the yellow arsenite of silver will be formed. If a paper stained with emerald green be touched with liq. ammoniæ, the spot and the liquid turn blue.

Symptoms.—Those of the acute form of poisoning may be inferred from the case of a print-colourer admitted into King's College Hospital, June, 1858. Death was caused by an ounce of the poison in seven hours, under symptoms belonging to the second variety of arsenical poisoning described at p. 455. He did not vomit till an emetic was given, and diarrhœa did not form a prominent symptom. He was pale, excited, faint, and anxious, with a small feeble pulse, slight epigastric tenderness, intense thirst, profuse cold sweats, severe cramps in the calves of the legs, and in the hands, with twitchings of the legs and arms. He never rallied, and died exhausted. The tongue was tinged green, and the matters rejected from the stomach and bowels were of the same colour. The stomach-pump was used, and the hydrated sesquioxide of iron freely given. The post-mortem appearances were a dirty green tongue; in the stomach a large quantity of the antidote speckled with green; congestion of its mucous coat, and of that of the small intestines; deep chocolate colour of the folds of the stomach, and dots of extravasated blood over the surface, especially near the pylorus. Lungs greatly congested; brain and kidneys sound.

It may be stated generally, that the symptoms, post-mortem appearances, and treatment of poisoning by the arsenite of copper and by the aceto-arsenite, are those of poisoning by arsenious acid. In two cases jaundice showed itself as if the copper had proved active.

Very severe, and even fatal, symptoms of irritant poisoning

have been induced by eating substances coloured with arsenite of copper.

Chronic Arsenical Poisoning.—An important source of chronic poisoning by arsenic is to be found in wall papers tinted with arsenical pigments. These become detached as a fine dust, which is both inhaled and swallowed. There is some reason, however, to believe, that volatile arsenical compounds are also formed, particularly arseniuretted hydrogen, by the action of moisture, lime, and the paste by which the papers are fixed (Fleck). Among the symptoms arising from this source, the following have been enumerated:—The sneezing and lachrymation of a common cold, cough, nausea and loss of appetite, sickness and diarhœa, colic pains, cramps, and spasms, dryness of the tongue and throat, and thirst; depression, headache, drowsiness and extreme weakness, or actual palsy of the extremities. (In one case the dropped hand, as in poisoning by lead, in another great weakness and unsteadiness of all the limbs.)

When the powder is largely diffused through the air, as in chromo-printing, the consequences may show themselves in a quarter of an hour, or even less; and they commonly appear in one or two hours in the shape of severe catarrhal symptoms, with headache and bleeding at the nose, followed after a time by the rash presently to be described.

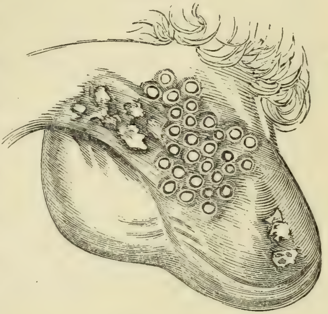
The persons employed in making artificial leaves, seeds, fruits and flowers, chiefly young women, suffer from catarrhal symptoms and sore throat; the rash on the neck, face, ears, head, arms, and pudenda; thirst, nausea, anorexia, pain in the stomach, and vomiting, colic pains and cramp, palpitation and shortness of breath; great weakness, fever, headache, dimness of sight, drowsiness, restlessness, tremblings, and convulsive twitchings.

One fatal case, at least, has occurred among young women following this occupation. In the one fatal case with which my inquiries made me acquainted, the occupation had been carried on for eighteen months, and she died in convulsions that had occurred every five minutes for seven hours and a half (G.).

Arsenite of copper mixed with warm size is largely used in making tinted papers and paper-hangings, and is so laid on as to come into contact with the hands of the workmen. After one or two days the men begin to suffer, and are soon obliged to abandon their employment. The first symptom is a papular rash, running on to pustulation, about the root of the nostrils. The back of the ears, the bends of the elbows, and the inside of the thighs suffer in order; and then the scrotum, which I have often seen sprinkled with superficial circular ulcers from the size

of a split pea to that of a fourpenny piece, looking as if cut by a punch. Sometimes the fingers are inflamed, and the nails drop off. The pulse is sometimes quickened, and occasionally the eyes smart and the epigastrium is tender. On abandoning the employment, the effects soon pass away; and they might certainly be avoided by scrupulous cleanliness and simple precautions to avoid contact with the poison.

Fig. 75.



The effect of the poison on the scrotum is seen in fig. 75, which shows both the circular ulcers just described, and the diffused and ragged ulcerations figured by Dr. Vernois I have seen the circular ulcers more than once (G.). The ulcerations of the fingers are well shown in fig. 76, after an illustration by Vernois. The green powder is found adhering to their edges.*

Fig. 76.

Arsenic is largely used in the preparation of the aniline colours, and these often contain a large proportion of arsenic acid as an impurity. (*See* 'Pharm. Journ.,' 1868, Oct.; 'Brit. Med. Journ.,' 1868, Oct.) Cases of poisoning have occurred in aniline dye manufactories, and local eczematous affections have resulted from under-clothing dyed with these materials.

* Dr. Prosper de Pietra Santa, in the 'Annales d'Hygiène,' October, 1858, p. 339, gives a similar account of the effects of Schweinfurt green as used in

Arsenate and Binarsenate of Potash.—These are active poisons little used in this country. The arsenate is white, deliquescent, and very soluble, with the reactions of "arsenic acid." The binarsenate is known as "Macquir's neutral arsenical salt."

The Arsenate of Soda is used as a medicine in France. A grain to an ounce of water constitutes "Pearson's solution;" and a solution of 4 grains to the ounce of water, the liq. sodæ arseniatis of the B.P. A paper soaked in a solution of one part of arsenate of soda, two of sugar and twenty of water, is in use for poisoning flies. The "*papier moure*" owes its poisonous properties to this salt.

Sulphides of Arsenic.—Realgar, or red arsenic, and orpiment, or yellow arsenic, and King's yellow, which consists chiefly of orpiment, are used for tinting paper, and other similar purposes. Both orpiment and King's yellow contain arsenious acid, often in considerable quantities. The yellow sulphide of arsenic is the precipitate thrown down by sulphuretted hydrogen gas from liquids containing arsenious or arsenic acid, and their compounds. It is also occasionally taken as a poison; and is sometimes found adhering to the coats of the stomach after death, having been formed, as already stated, by the union of arsenious acid with nascent sulphuretted hydrogen, the product of decomposition. In organic mixtures the sulphides are detected by their characteristic colours. They are soluble in ammonia, and thrown down from the ammoniacal solution by hydrochloric acid. When mixed with black flux, or cyanide, and heated, they yield metallic sublimates (see p. 441); and when boiled with nitro-muriatic acid, they are converted into arsenic and sulphuric acids.

The symptoms of poisoning by the sulphides are those of poisoning by arsenious acid; and the post-mortem appearances are also the same, with the exception that the contents of the alimentary canal have a yellow colour, and that the mucous membrane is tinged of the same hue. The treatment is that of poisoning by arsenious acid.

Arseniuretted Hydrogen.—Several cases of poisoning by this gas, which is very rich in arsenic (each cubic inch containing little short of a grain of the metal), are on record. The

Paris. See also memoir by M. A. Chevallier in the same journal, July, 1859. a paper by Dr. Vernois in the 'Annales d'Hygiène,' year 1839, p. 346; and Dr. Guy's report on 'Alleged Fatal Cases of Poisoning by Emerald Green, &c.,' in the 'Fifth Report of the Medical Officer of the Privy Council,' 1862. See also Dr. Kirchgässer on poisoning by wall papers, in the 'Vierteljahrschrift f. Gericht. Med.,' ix. p. 96, of which there is also a full abstract in the 'Biennial Retrospect of the Sydenham Society' for 1867-68. Hirt's work, 'Krankheiten der Arbeiter' contains a very complete summary of investigations on this subject.

celebrated chemist Gehlen died on the ninth day from the effects of the inhalation of arseniuretted hydrogen. It has been more than once generated, instead of hydrogen, by sulphuric acid containing arsenic. A very interesting series of cases affecting a whole family, and due to the inhalation of the gas evolved from decomposing arsenite of copper, has been related by Dr. Elliotson. The symptoms were nausea, vomiting, thirst, watering of the eyes, red and foul tongue; a rapid pulse, ranging from 120 to 160, and, after apparent recovery, pains in the limbs. The patients derived much advantage from blood-letting. The poison seems to be eliminated by the kidney, in which organ it gives rise to severe irritation. In two instances cited by Christison, and in a third case by Vogel,* it occasioned hæmaturia. Valette records two cases of poisoning by this gas, one of which proved fatal on the thirtieth day ('Lyon Médical,' 1870, 7, p. 440).

Compound cases of poisoning by arsenic occasionally occur, that by arsenic and opium jointly being most frequent. The opium masks the characteristic action of the arsenic, so that the case resembles those rare instances of arsenical poisoning in which narcotic symptoms are very prominent. Such was the character of a case of poisoning by arsenic and laudanum which occurred some years since in King's College Hospital.

II. ANTIMONY AND ITS PREPARATIONS.

A few years since, poisoning by antimony was so rare, that the poison is not specified in the list of substances that proved fatal in the five years 1852-56. But since the trials of Palmer, Dove, McMullen, Hardman, Freeman, Smethurst, Winslow, and Pritchard, and the inquest on the death of Mr. Bravo, at Balham (1876),† the subject of poisoning by antimony, and especially by small repeated doses of tartar emetic, has assumed great importance.

The preparations of antimony which are important in a medico-legal point of view, are tartar emetic and the chloride. The precipitated sulphide is of interest from being developed in testing for the poison.

The *metal* antimony shares with arsenic the property of combining with nascent hydrogen, and of being deposited in the metallic form on burning the jet of gas, or heating the glass tube through which it is passing. It differs from arsenic in not being

* 'Brit. and For. Med.-Chir. Review,' Jan. 1854, p. 279.

† 'Lancet,' May 20, 1876. A case which excited great attention, and which still remained a mystery, so far as the administration of the poison was concerned, after two judicial investigations.

volatilized, when in the mass, by the heat of the spirit-lamp, and with difficulty when in the form of thin films. In common with arsenic, mercury, and several other metals, it is deposited in the metallic form on copper, when its solutions are treated after the method of Reinsch. The metal antimony often contains a minute fraction of arsenic. In the arts it is employed chiefly in the manufacture of type metal.

The precipitated sulphide, formed by transmitting a stream of sulphuretted hydrogen through a solution of a salt of antimony, or by treating metallic stains of antimony with sulphide of ammonium, is of a characteristic orange-red colour, and, like the black prepared sulphide, yields metallic antimony when heated in a current of hydrogen gas.

TARTAR EMETIC (*Tartarized Antimony, Stibiated Tartar, Potassio-Tartrate of Antimony*).

This substance is found in the shops as a white powder, or as yellowish-white efflorescent crystals. In common with antimonial wine and James's powder, it may contain minute traces of arsenic, derived either from the metal antimony, or from the sulphuric acid used in its manufacture.

Properties.—Tartar emetic is soluble in about three parts of boiling and fifteen of cold water, but insoluble in alcohol; and it has a sickly metallic taste, and faint acid reaction.

Tests.—We may have to test for the poison in *substance*, in *solution*, in *organic mixtures*, and in the *fluids and tissues.*

1. *In Substance.*

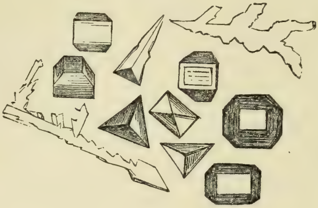
a. Heated by the flame of a spirit-lamp it decrepitates and chars and if the blowpipe is used, the metal is reduced. *b.* When heated in the manner described at p. 441, it is found to decrepitate at 380°, to sublime slowly and scantily (yielding an amorphous deposit on the glass disk) at 480°, and to char at 550°. *c.* When treated with sulphuretted hydrogen, or sulphide of ammonium the characteristic orange-red sulphide is formed.

2. *In Solution.*

a. A drop of a solution of tartar emetic evaporated on a slip of glass leaves a crystalline deposit, which, when examined by lens or microscope, is found to contain well-formed crystals that are either tetrahedra, or cubes with the edges removed, or some modification of the cube. Sometimes all the crystals assume the one shape

sometimes the other; but both kinds are often found in the same specimen, as in fig. 77; together with the branched crystalline forms so common in deposits from saline solutions. The best crystals are obtained from hot solutions.

Fig. 77.



b. The solution is proved to contain a salt of antimony, by giving an orange-coloured precipitate with sulphuretted hydrogen, or sulphide of ammonium. This precipitate is soluble in caustic potash, in a large excess of ammonia, and in strong hydrochloric acid. The acid solution lets fall a white precipitate when largely diluted with water. The sulphide is also decomposed when boiled in hydrochloric acid, sulphuretted hydrogen being given off, and chloride of antimony remaining; and it may be reduced to the metallic state by heating it in a current of hydrogen gas.

c. The following are confirmatory tests:—1. The three dilute mineral acids throw down a white precipitate, which is redissolved by the acid in excess, and by a solution of tartaric acid. Of these acids the nitric is least open to objection, but the three conjointly are conclusive. 2. A strong infusion of gall-nuts gives a dirty yellowish-white precipitate. 3. Ferrocyanide of potassium causes no precipitate.

d. Introduce some of the solution into a Marsh's apparatus, and proceed as with arsenic (p. 447). The crusts obtained from the inflamed jet generally have a more smoky appearance than those of arsenic, but some antimony crusts may be mistaken for those of the latter metal. For the mode of distinguishing the crusts of the two metals, see p. 449. The crusts in the horizontal tube have a characteristic shape (fig. 71, p. 449) and tin-like lustre. If the antimoniuretted hydrogen issuing from the apparatus is led into nitrate of silver, a black precipitate is thrown down, of antimony in combination with silver. If this precipitate is boiled with tartaric acid, the antimony is dissolved, and may be recognised by the sulphuretted hydrogen and other tests.

e. Treat the solution by Reinsch's method (p. 450), taking care to use pure copper foil. The antimony deposit has generally a violet tint, and does not yield a crystalline sublimate. It may be removed from the copper, either—1, by boiling the metal in

a weak solution of permanganate of potash rendered slightly alkaline by liquor potassæ (Odling); or, 2, by a weak solution of potash and the frequent exposure of the metal to the air (Mr. Watson). If the first process is adopted, the antimony solution must be freed from the brown deposit of hydrated peroxide of manganese by filtration, slightly acidulated with hydrochloric acid, and treated with sulphuretted hydrogen gas. If the second process is adopted, the solution is filtered, acidulated with hydrochloric acid, and treated with sulphuretted hydrogen.

f. The metal may be separated from liquids containing it by the process of electrolysis described at p. 452. It is deposited on the platinum plate connected with the negative pole of the battery, and may be identified either by washing it with sulphide of ammonium, and evaporating the solution, or by either of the methods just described.

3. *In Organic Liquids.*

All vegetable substances containing tannin decompose the salts of antimony, and milk is coagulated by their strong solutions. Several vegetable substances also affect the action of the tests. Coloured fluids, though they modify the action of the other tests, have little effect on the gaseous test, the sulphide retaining its characteristic colour. If no antidote has been given, and the poison has not been wholly rejected by vomiting, it may remain in the stomach unchanged. In this case we dilute, acidulate with tartaric acid, filter, transmit sulphuretted hydrogen gas, and obtain the characteristic orange sulphide. If this process fails, we adopt for the solid contents of the stomach and the coats of the viscera the same method as for the organic tissues.

The discovery of antimony, by either method, in the contents of the stomach proves that one of its preparations has been taken either as medicine or as a poison; and if the quantity exceeds that of an ordinary medicinal dose, there is strong presumption of poisoning; but when the quantity is small, we cannot state that it has been administered as a poison, unless we can prove that it was not given as a medicine. Antimonial emetics are of course inadmissible in cases of poisoning.

4. *In the Tissues.*

Antimony is absorbed, and may be found in the secretions, blood, and viscera. The process for detecting the poison is that already recommended for arsenic (p. 452). The resulting acid liquor may be treated after Reinsch's method (p. 450), or that of Marsh (p. 447), or by electrolysis (p. 452). If by Reinsch's

method, the metal must be identified in the manner just described; if by Marsh's method, by the characters described at p. 449.

The method of separation of antimony from arsenic and tin has been described at p. 451.

The antimoniate of soda which is formed by burning the sulphide with carbonate and nitrate of soda, is insoluble in water, and is thus capable of separation from the soluble arsenate of soda. When this is fused with cyanide of potassium it is reduced to the metallic state. Should tin be present, this also is reduced to the metal. Tin, however, is soluble in hydrochloric acid, but antimony is not dissolved until after the addition of nitric acid. A chloride of antimony is formed, and when the excess of nitric acid is driven off by heat, a solution is obtained which gives all the reactions of antimony.

Quantitative Analysis.—Use the precipitated sulphide, carefully washed and dried. One hundred parts correspond to 203 of crystallized tartar emetic.

Experiments on Animals.

Such large doses of tartar emetic as half an ounce, may be given to dogs with impunity if they are allowed to vomit; but a few grains are fatal when the gullet is tied. Injected into the veins, it causes vomiting and purging, and leaves marks of acute inflammation in the alimentary canal and in the lungs. In some instances of speedy death, there has been no inflammation in any organ.

An interesting series of experiments on slow poisoning by antimony was made by Dr. Nevins ('Liverpool Medico-Chirurgical Journal,' No. 1), in illustration of the death of M'Mullen, attributed to the repeated administration of small doses of tartar emetic by his wife. The animals selected for experiment were rabbits, eleven in number, to which tartar emetic in powder was given four times a day, in doses of half a grain, a grain, and two grains. The quantity required to destroy life was twelve grains in a feeble rabbit, and seventy-two in the longest survivor. Five of the rabbits died, the first after four, the last after seventeen days. Three survived after taking the poison seventeen days; and three were killed, after one, three, and four days respectively, two after an interval of fourteen days, and one thirty-one days after the last dose.

The *symptoms* were loss of appetite, loss of spirit, and, after the sixth day, great emaciation. None of the rabbits vomited; and diarrhœa was absent in five out of eight. There were no

cramps; but three of the five that died of the poison were violently convulsed a few minutes before death, and a fourth slightly so. Several had ulceration of the mouth, from contact with the poison. One rabbit, being with young, aborted.

The *post-mortem appearances* consisted in congestion of the liver in all the rabbits, vivid redness of some part of the lining membrane of the stomach in most, ulceration in two; and cartilaginous hardness of the pylorus in some. The small intestines in some of the animals presented patches of inflammation throughout, and, in two, all the solitary glands were enlarged, prominent, of a bright yellow colour, and loaded with antimony. The colon and rectum were nearly always healthy. In two instances the mucus of the stomach or bowels had a brownish colour, attributed to the formation of the sulphide. The kidneys were generally more or less congested, and the bladder vascular, and distended with urine. This was not the case, however, in the animals that were killed after a few days, or some time after the discontinuance of the poison. The brain, heart, and spleen were always healthy, but the lungs in many cases were deeply congested, and in some acutely inflamed, sometimes hepatized, and gorged with blood, the air tubes being of a bright-red colour. Bloody extravasations (or exsudations) were found in the cavities of the chest and abdomen, and also between the muscular and mucous coat of the cæcum, in more than one instance.

The poison was found, by Reinsch's test, in every part of the body—always in great abundance in the liver; in smaller quantity in the spleen; at the earliest period in the tissues of the stomach; at a later period in the kidneys, and in the cæcum. The fæces always contained the poison—in one rabbit killed fourteen days, in another twenty-one days after the last dose. Antimony was also found in the lungs from an early period. In the muscles and in the blood it was difficult to detect; but it was found in the bones on the fifteenth day, and thirty-one days after the poison had been discontinued. It was also found in the fœtal rabbits, of which one of the animals aborted.

The poison was being constantly eliminated by the kidneys. It was discoverable in the urine after the twelfth dose: and in that voided twenty-one days after the poison had been suspended. This fact is in conformity with what has been already stated (p. 455), relative to the slow elimination of arsenic from the system. From these experiments Dr. Nevins infers—"that tartar emetic is a deadly poison when repeated in small doses for a sufficient length of time; but that the total quantity necessary for causing death, and also the length of time required, are very vari-

able in different cases; that there is a considerable general similarity in the symptoms and morbid appearances produced, but by no means absolute uniformity; that the poison permeates almost all the tissues of the body, and even those of the unborn offspring, if its administration is continued long enough, whilst, at the same time, it is constantly being eliminated from the system by the kidneys and bowels; and lastly, that the fatal effects are often disproportionate to the apparent changes found after death."

These conclusions are generally in harmony with the results of the experiments of Messrs. Millon and Lavran, made in 1846. ('Annales d'Hygiène,' vol. xxxvi. p. 221). Numerous experiments have been made of recent years* on the action of tartar emetic. It causes vomiting when injected into the veins, and this too, as Magendie showed, after removal of the stomach.

Saikowsky has observed in animals a fatty degeneration similar to that caused by phosphorus and arsenic, but less pronounced.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms of acute poisoning in the human subject are:—a strong metallic taste perceived in the act of swallowing, with heat, constriction, and soreness of the mouth and throat, followed by nausea, vomiting, and pain and tenderness of the epigastrium, extending to the whole abdomen. Repeated and profuse diarrhœa soon follows the discharges sometimes containing blood, with severe cramps of the extremities, and symptoms of collapse: cold skin, clammy sweats, a small quick pulse, and great weakness. Death may happen in this state of collapse; but it is sometimes preceded by delirium, convulsions, and tetanic spasms. Large doses sometimes occasion insensibility as one of their earliest effects. In more than one instance the characteristic pustular rash has been present on the skin and in the throat. In some exceptional cases there has been no vomiting and no purging till other emetics were administered.

Fatal Dose.—In an adult, two grains; in a child, $\frac{3}{4}$ of a grain. (Taylor, 'Guy's Hospital Reports,' Oct. 1857). One drachm of tartar emetic killed a healthy adult in ten hours. A grain and a half given with fifteen grains of ipecacuanha two days running caused vomiting, purging, prostration, and death in a healthy woman five days after her confinement. ('Med. Times and Gaz.,' March 28, 1857.) Children have been killed by ten grains in a few hours. On the other hand, such large doses as three drachms have been frequently swallowed with impunity, in

* See Hermann, 'Experim. Toxicol.,' 1874.

consequence of its prompt rejection from the stomach; or recovery has taken place without early spontaneous vomiting, but with profuse diarrhœa, after the occurrence of very dangerous symptoms.* Very severe effects have been produced by so small a dose as six grains. But it has often been given in pneumonia in doses of two grains, repeated at short intervals, without injurious consequences.

Fatal Period.—Tartar emetic, in a single large dose, may kill in a few hours (in an adult female, quantity unknown, in seven hours—Wormley); but, on the other hand, a patient survived nearly five days the taking of forty grains, and a scruple of the poison proved fatal to a woman after a year of suffering.

Mortality.—Somewhat less than half the cases.

Tartar emetic applied externally in lotion or ointment causes inflammation of the skin and a crop of pustules, and, if continued, may produce sloughing. Nausea and vomiting have sometimes attended this external use of the poison.

Post-mortem Appearances.—Inflammation of the mucous membrance of the stomach, extending sometimes to the small intestines; rarely to the throat and gullet. In the Bravo case, the stomach and small intestines were singularly free from signs of irritation, while the large intestines and particularly the cæcum were inflamed. In the cæcum small pustular ulcers existed and hæmorrhagic extravasations. The lungs are sometimes said to be inflamed, but the so-called inflammation of the lungs is more probably marked hypostatic congestion. This also was seen in the Bravo case. After death by repeated small doses, special attention should be paid to the state of the cæcum and large intestines.†

Treatment.—The best antidote is tincture of cinchona bark. When this is not at hand, the decoction or powder may be substituted, or liquids containing tannin, such as strong tea, or decoction of oak bark. In the absence of the antidote, or while it is being prepared, vomiting should be promoted by warm water, milk, or mucilaginous drinks, and by tickling the throat with a feather; or the stomach-pump may be employed. The after-treatment must be determined by the symptoms. Opium may be prescribed with advantage.

Chronic Poisoning.—The experiments of Dr. Nevins have removed any doubt which may have attached to recent medico-legal

* Case by Dr. Gleaves: Wormley's 'Micro-Chemistry of Poisons,' p. 216.

† See *ante* for the appearances in animals; and for the appearances in the human body in one case where antimony was found, and believed to have been repeatedly administered, see 'Observations on the Medical Evidence in the case of The Queen *v.* Smethurst.' By T. G. Geoghegan, M.D., 'Dublin Med. Press,' 1859.

cases, as to the power of tartar emetic, in repeated small doses, to destroy life. It gives rise to nausea, vomiting and purging, extreme debility, and fatal exhaustion; and the like symptoms have occurred in man.* In infants and young children, especially when suffering from diseases such as croup, there seems to be great tolerance of tartar emetic, as was proved by several cases related or quoted by Dr. Elliotson. But tetanic symptoms were present, as in some cases of poisoning in the adult. ('Med. Times and Gazette,' July 5, 1856.)

Chloride of Antimony (Butter of Antimony).

A corrosive liquid, of a light-yellow or dark-red colour, which has been taken by mistake for ginger-beer, and for antimonial wine. When largely diluted with water the white oxychloride of antimony falls down, and the clear liquid is proved to contain hydrochloric acid by the addition of nitrate of silver. The subsidence of a white precipitate on adding water in excess also occurs with solutions of the salts of bismuth: but with sulphuretted hydrogen bismuth yields a black, and antimony an orange-red precipitate.

Symptoms.—The action of the chloride is both prompt and violent. In one case, death took place in ten hours and a half after swallowing between two and three ounces. Narcotic symptoms were added to those of violent irritation of the alimentary canal, and the mucous membrane of the entire canal presented a charred appearance, and was softened and abraded. Recovery has taken place after swallowing an ounce of the poison.

Treatment.—As in poisoning by tartar emetic. After large draughts of warm water, promptly administered, the tincture of bark.

III. MERCURY AND ITS PREPARATIONS.

These are in common use in the arts and in medicine, and they are occasionally used as poisons. They take the seventh place among the ascertained causes of death by poison, coming next after oxalic acid. Corrosive sublimate is the preparation usually taken or given as a poison. The majority of cases are suicidal. Metallic

* See Dr. Geoghegan's paper just quoted; and for a full report of the trial of Dr. Pritchard for the murder of his wife and mother-in-law, 'Edin. Med. Journal' for 1865. In Mrs. Pritchard's case the symptoms led to the idea on the part of one of the witnesses that she was under the influence of alcohol—viz., flushed face, rapid weak pulse, an excited manner, with great muscular weakness, vomiting, purging, and cramps in the hands. Dr. Pritchard tried to make it appear that his wife was suffering from typhoid fever, to which the symptoms had some resemblance. It was proved that they were due to the administration of tartar emetic in repeated doses.

mercury, as used in the arts, gives rise to severe and well-defined maladies, and its medicinal preparations occasionally prove fatal in an overdose, or in an ordinary dose to persons very susceptible to their action. The metal itself is inert, and may be given in large quantities without injury; but its oxide when diffused through the air, or brought into constant contact with the skin, is known to produce injurious effects.

The metal sublimes unchanged at 660°, and when the sublimation is conducted in a glass tube, a ring of small metallic globules is deposited. When more minutely divided, it has the appearance of a black powder; in which form it is thrown down from solutions of its salts.

The chief preparations of mercury are:—the chloride or corrosive sublimate; the sub-chloride, or calomel; the ammonio-chloride, or white precipitate; the red oxide, nitric oxide, or red precipitate; the sulphide, cinnabar, or vermilion; the mercuric sulphate, or Turpeth mineral; the bicyanide, or prussiate; and the two nitrates. Corrosive sublimate is by far the most important.

CORROSIVE SUBLIMATE (*Oxymuriate, Corrosive Muriate, Bichloride,* more properly *Chloride, of Mercury*).

This substance is used for preserving the feathers of birds and skins of animals from moth; for destroying bugs and lice and maggots in man and in animals; and when dissolved in spirits of sweet nitre, as a popular remedy for gonorrhœa and syphilis.

Properties.—A very heavy crystalline mass, or white powder, of a peculiar nauseous taste, permanent in air, but slowly decomposed in sunshine, an insoluble grey powder being formed. It dissolves in twenty parts of cold, and two of boiling water; and is more soluble in alcohol and ether; hence ether is used to remove it from its aqueous solutions. Common salt, also, renders it more soluble.

Tests.—We may encounter the poison in *substance,* in *solution* in *organic liquids,* and in the *tissues and organs of the body.*

1. *In Substance.*

When heated on platinum foil it is wholly dissipated in white acrid fumes. Heated on a porcelain slab with the flame of a spirit-lamp, it sublimes at 200° Fahr., and melts at a higher temperature. The sublimate received on a glass disk consists of small groups of plates mostly drawn to a point at one or both ends, and often radiating two, three, or more from a point. Fig. 78 shows a coarse, and fig. 79 a more delicate specimen, the last from a photograph. The appearance shown in fig. 80 is less common in

sublimates than in deposits from liquids. If a sublimate does not happen to be characteristic, a minute drop of liquor potassæ applied to one part of it, and of solution of iodide ofpotassium to another, will identify it by the yellow and scarlet reactions. These tests are conclusive. The great solubility of corrosive sublimate in water further distinguishes it from arsenious acid and calomel.

Fig. 78.

Fig. 79.

× 60.

The addition of liquor potassæ places the nature of the substance beyond a doubt. It turns yellow, while arsenic undergoes no change, and calomel is blackened. We may obtain still further assurance by the following tests: 1. Sulphide of ammonium blackens the powder. 2. Iodide of potassium turns it to a bright scarlet. 3. A clean rag moistened with dilute hydrochloric acid, and sprinkled with the powder, when rubbed on a clean plate of copper, leaves a silvery stain readily volatilized by heat. 4. Mix one part of the poison with four parts of calcined bicarbonate of soda; place the mixture in a dry reduction-tube (fig. 58, p. 441), or in the short tube (fig. 59, p. 441), and cautiously apply the heat of a spirit-lamp; a ring of globules will be formed on the cool sides of the test-tube, or on the glass disk placed over the mouth of the short specimen-tube.

2. *In Solution.*

a. On the supposition that we are ignorant of the contents of a liquid submitted to analysis, we may ascertain that it contains a crystalline salt by evaporating a drop on a glass slide, and examining the dry spot by the microscope. Corrosive sublimate is deposited, in long single needles, plates branched or stellate, as in figures 78, 79, or in parallel groups of needles or plates, as in fig. 80. *b.* Sulphuretted hydrogen yields with corrosive sublimate a black precipitate, first giving a milky appearance to the liquid. *c.* Sulphide of ammonium also gives a black precipitate. *d.* With liquor ammoniæ it yields, in common with lead and bismuth, a

Fig. 80.

white precipitate, but with liquor potassæ a yellow (the hydrated oxide). By this we recognise a per-salt of mercury. The supernatant liquor contains chloride of potassium. *e.* This yellow precipitate being collected, washed, and dried, and heated in a reduction-tube, gives a well-defined ring of mercury. The sulphide precipitated by sulphuretted hydrogen, or by sulphide of ammonium, when dried and heated with bicarbonate of soda, also yields a ring of mercury.

Additional tests: 1. Protochloride of tin. A solution of this substance throws down a white precipitate, turning rapidly grey, and from grey to black. The black deposit is minutely divided mercury. The supernatant liquor being decanted or separated by filtration, and the deposit dried, the globules coalesce. 2. Metallic test. Acidulate the liquid with a few drops of hydrochloric acid, and introduce a narrow slip of clean copper. A grey film will be formed on its surface. This being carefully dried, placed in a reduction tube, and heated by the spirit-lamp, yields a ring of metallic globules. Pure tin, zinc, or silver may be substituted for copper; but the latter is to be preferred. 3. Galvanic test. Take a narrow strip of zinc foil, and coat it with gold leaf; drop this into the solution slightly acidulated with hydrochloric acid; the gold will soon be covered with a grey film. Remove it from the solution, dry it carefully, introduce it into a reduction-tube, and heat it. A ring of metallic globules will be formed. This test is applicable to very minute quantities. The metallic deposit may be readily obtained by placing a drop of the acidulated solution on a surface of clean copper or gold, and touching the moistened metal with a fragment of zinc or iron. Wollaston once showed this reaction in court, with a key and a sovereign.

Mercury is one of the metals deposited on copper when its solutions are treated by Reinsch's method (p. 450). The copper dried, and heated in a reduction-tube, yields a ring of metallic mercury.

The acid in combination may be shown to be the hydrochloric by testing the fluid from which the mercury has, by any of the foregoing methods been precipitated, with nitrate of silver, which yields a white precipitate of chloride of silver.

3. *In Organic Liquids.*

Corrosive sublimate is sometimes swallowed in substance, or imperfectly dissolved; and though very soluble, may be found in the stomach in a solid form, and may be separated by diluting the viscid contents with distilled water, stirring them, allowing

the heavy corrosive sublimate to subside, and quickly pouring off the supernatant liquor. More commonly the poison is given dissolved in water or in some liquid suited to disguise its taste; and, when so given, may be decomposed by the contents of the stomach, or by the mucous membrane itself. Hence the poison may exist in the stomach partly in solution undecomposed, partly combined with its contents, partly in union with its coats.

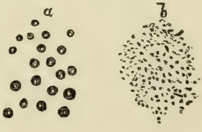
If any of the poison exists in the free state, it may be readily separated by diluting the contents of the stomach with distilled water, obtaining a clear liquid by filtration, shaking it in a stoppered bottle with an equal bulk of ether, and drawing off the ethereal solution with the pipette. By evaporating a drop of the solution on a glass slide, the crystals depicted in fig. 80 will remain, and may be tested by minute drops of the reagents.

The solid contents of the stomach may be examined by the same method as for the organic tissues.

4. *In the Organic Tissues.*

Bring the organic matters into a state to pass the filter by the method described at p. 453; and test the liquid by the method of Reinsch (p. 450). If the copper receives a grey coating, wash it in distilled water, dry it, and heat it in a reduction-tube (fig. 59, p. 441). Globules of metallic mercury will be deposited on the cool side of the tube, or on the glass disk (fig. 60, p. 441). When, as in examining the tissues, we have to deal with small quantities of mercury, we should employ the form of reduction-tube figured at p. 444. This test is a very delicate one. The five-thousandth of a grain can be readily sublimed and identified. The appearance of a group of globules obtained from this small quantity of the metal is shown in *a*, fig. 81, where they are magnified 70 diameters and measure the two thousandth of an inch. Sometimes the metal is oxidized, and then presents the appearances depicted in *b*. fig. 81. Among spots of no very defined shape are found a number of prismatic crystals, some scarcely longer than their breadth, while others are long needles.

Fig. 81.



As arsenic deposited on copper by Reinsch's process, and sublimed in the same way, may also yield distinct globules (fig. 59, p. 437), having a strong metallic lustre, the one may have to be distinguished from the other.

The distinction is rendered easy by the fact that the globules of arsenic obtained in this way are always mixed with the

characteristic octahedral crystals of arsenious acid, while those of mercury are either unmixed, or blended with the small needles just described and figured.

When a liquid found in the stomach, or obtained by simple boiling, yields mercury by any of the processes now described, we have evidence of a soluble salt of mercury, and a strong presumption in favour of corrosive sublimate; but when the solid matters after evaporation to dryness are treated with hydrochloric acid, we have no evidence of a soluble salt, because even an insoluble salt, thus treated, would be converted into corrosive sublimate. This process, then, is open to the objection that the mercury which it is the means of discovering may have been administered as a medicine in the form of calomel, blue pill, or grey powder. This objection could only be answered by distinct evidence of such substances not having been given as medicine, or by the characteristic symptoms and post-mortem appearances due to corrosive sublimate being present. The sulphide of mercury prepared from the acid solution after the destruction of the organic matter is distinguished from the similar sulphides of lead and copper by yielding a sublimate of metallic mercury when heated with bicarbonate of soda, and also by its insolubility in nitric acid. The sulphide of mercury is readily soluble in nitro-hydrochloric acid. It may be dissolved in this and tested by the various methods described.

Quantitative Analysis.—The quantity of the poison is best determined by means of the perchloride of tin. This should be added to the liquid containing the poison so long as any precipitate falls, which should then be washed, dried, and weighed. Of the metallic mercury thus thrown down, 100 grains correspond to $135\frac{1}{2}$ grains of corrosive sublimate. If estimated as the sulphide, 100 of the washed and dried sulphide correspond to 116·81 of the corrosive sublimate.

When there is reason to believe that the quantity of the poison is considerable, we may follow with advantage the summary process recommended by Christison. The solid matters are to be triturated with protochloride of tin, when the mixture will assume a slate-grey colour, and separate readily into a liquid and coagulum. The liquid may be rejected, but the coagulum, having been washed on a filter, must be carefully removed and boiled in a moderately strong solution of caustic potash until all the lumps disappear. The oxide of tin with the animal and vegetable matter is thus dissolved, and the solution, on remaining at rest, deposits a heavy grey powder, consisting chiefly of finely divided mercury. To separate the mercury completely, the solution must be allowed

to remain at rest, at a temperature little short of boiling, for about twenty minutes. The supernatant liquor may then be drawn off, and the remaining black powder, after repeated washings, may be removed, dried, and sublimed.

Corrosive sublimate, like arsenic and other active poisons, may be rejected from the stomach so as not to be detected after death.

Experiments on Animals.

The experiments of Sir Benjamin Brodie show that corrosive sublimate is a very active poison. Six grains dissolved in six drachms of water killed a rabbit in $4\frac{1}{2}$ minutes, and a scruple proved fatal to a cat in 25 minutes. The rabbit became insensible in three minutes, and was convulsed; and on opening the chest the heart had ceased to beat, and its left cavities contained scarlet blood. The mucous membrane at the cardiac end of the stomach was of a dark grey colour, much softened and readily detached; but similar effects were produced by the poison after death. Sir B. Brodie attributed its fatal effects to this chemical action. Dr. Bostock and other experimenters, by giving smaller doses, produced the common symptoms of irritant poisoning, followed by death after some hours; and on dissection the mucous membrane of the stomach was found inflamed. More recent experiments, while apparently establishing the fact that the corrosive action of salts of mercury depends on their solubility and affinity for albumenoids, have not thrown much light on the constitutional toxic effects of mercury and its compounds.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Immediately, or within one or two minutes of swallowing a substance or liquid of a peculiarly nauseous, metallic, styptic taste, there is a sense of tightness and burning in the throat and gullet, greatly increased by pressure, and by attempts to swallow, speedily followed by burning pain in the epigastrium, also increased by pressure. Vomiting and purging of stringy mucus or of bilious matter often containing blood ensue, and the entire abdomen becomes distended and exquisitely painful. The face is generally flushed and swollen, and the eyes sparkling; but in other cases it is pale and anxious, the lips white and shrivelled, and the eyes dull but expressive of great anxiety. The diarrhœa is accompanied with tenesmus, and dysuria is often present, the secretion of urine being scanty or altogether suppressed. The pulse is full, quick, and frequent, or small, frequent, and intermittent, according as the symptoms are those of high fever or

of collapse; and the breathing is quick and catching. In some cases there are drowsy intervals of comparative ease, and this drowsiness sometimes deepens into coma. Cramps, twitchings, and convulsions of the limbs, are often present from an early period; and occasionally there is paralysis. Death takes place during a faint, in the midst of strong convulsions, or during protracted insensibility. To these symptoms, in most cases which do not prove rapidly fatal, salivation is superadded, and the painful train of nervous symptoms caused by the specific effect of mercury on the system.

But the symptoms are by no means uniform, nor is the mode of death always the same. Three varieties of cases at least may be recognised:—1. Violent irritation of the stomach and bowels, with collapse. 2. Salivation and other remote effects, with little or no irritation of the alimentary canal. 3. Irritation of the stomach and bowels, followed by salivation and remote constitutional effects.

Diagnosis from Arsenical Poisoning.—According to Christison, the symptoms of corrosive sublimate commence sooner; the acridity and contraction of the throat are more marked; the discharges more frequently bloody; and the irritation of the kidneys more pronounced.

Constitutional Effects of Mercury.—1. When mercurials are absorbed in sufficient quantity into the system either during medicinal administration, internally or externally, or from their use in the arts, various constitutional effects manifest themselves. Among the first and most characteristic of these is *mercurial salivation*, characterized by a brassy taste, a peculiar fœtor of the breath, tenderness and swelling of the mouth, inflammation swelling, and ulceration of the gums, an increased flow of saliva a quick pulse, hot skin, and other symptoms of fever. In the worst cases the salivation is profuse; the face, neck, and tongue swollen; the inside of the mouth ulcerated or gangrenous.

Several interesting questions arise out of this symptom of mercurial poisoning:—*a.* What is the smallest dose that wi[ll] occasion salivation? *b.* Can salivation be produced by other causes, and if so, can we distinguish it from the effects of mer[-] cury? *c.* What is the earliest period at which salivation ma[y] occur? *d.* How long may it last? *e.* Can salivation cease an[d] recur without a renewed use of the mercurial preparation? *f.* I[s] it possible to distinguish gangrene of the mouth, the effect [of] mercury, from the same disease due to other causes?

a. Smallest dose. There is much difference between indiv[i-] duals, between persons of different ages, and even in the sam[e]

person at different times, in respect of the quantity of mercury which can be borne. As a general rule, children are less susceptible of the action of mercury than adults, the robust than the delicate. The same female who in her ordinary state of health is affected with difficulty, shall, when suffering from anæmia, be salivated with a few doses of blue pill. In scrofula and Bright's disease, and in affections of the nervous system, very marked effects are often produced by small doses of mercury.* Again, there are many persons peculiarly susceptible of its action, and others whom large and repeated doses will not affect. Many instances of severe, and even fatal, effects from small doses are on record. In an apoplectic patient of Dr. Bright's, five grains of calomel placed on the tongue produced in three hours violent salivation, and such swelling of the tongue as to render scarifications necessary. Three grains of corrosive sublimate in three doses have caused violent ptyalism; three five-grain doses of blue pill, given one every night, have proved fatal; two grains of calomel have caused ulceration of the throat, exfoliation of the jaw, and death; and the external application of three drachms of mercurial ointment has destroyed life in eight days (Christison).

b. Salivation from other causes. Salivation may occur spontaneously, so as to constitute a disease in itself, or it may be due to the mere accumulation of saliva, through some disease of the throat, such as quinsey, preventing deglutition. It may even be occasioned by the imagination, as in a case related by Christison. Various preparations of gold, copper, lead, arsenic, antimony, and bismuth; sulphuric acid, iodine, and iodide of potassium; several vegetable substances, such as castor-oil, foxglove, opium, and prussic acid, have also given rise to salivation; and jaborandi, which has lately come into use as a medicine, is a powerful sialagogue.

The distinction between mercurial salivation and that due to other causes is generally easy, in the first stage. Mercurial salivation is preceded by a coppery taste and peculiar fœtor of the breath, and accompanied by redness, sponginess, and ulceration of the gums. These are wanting in spontaneous salivation, and in that produced by most of the medicines just mentioned.† But

* In a case of paralysis of the facial nerve which came under my notice, there was a distinct red line upon the gums of the paralysed side, while the other was quite free. The sensibility of the affected side was perfect, though the patient complained of tingling (G.).

† A case under my care when a former edition of this work was in the press, seems to justify the cautious statement in the text. All the symptoms of severe mercurial salivation were present as the effect of a course of iodide of potassium, in the ascertained absence of mercurial preparations, other than those given from time to time as aperients, such aperients not having previously affected the system (G.).

the advanced stage of mercurial salivation seems to differ less strikingly from some severe affections of the mouth due to other causes, and accompanied by ptyalism. Thus, in a curious account of an epidemic salivation, forming part of a tertian fever, quoted from Haller's 'Collections' on the authority of Quelmelz, it is stated that in one instance it was as great as the most violent mercurial salivation, and was accompanied by fœtor, superficial ulceration of the mouth, pustules on the tongue, relaxation of the gums, and looseness of the teeth (Christison).

c. Earliest period. Mercurial salivation rarely sets in under twenty-four hours; but in Dr. Bright's case just cited, it appeared in three hours. In a case of poisoning by two drachms of corrosive sublimate, it began in four hours (Taylor). The shortest period, therefore, may probably be stated at three hours.

d. Duration. This is very variable, and may continue for any period from a few days to as many years. In one instance it is alleged to have lasted six years ('Lancet,' No. 453).

e. Intermittent salivation. Dr. Robert Williams ('Elements of Medicine,' vol. ii. p. 523) gives a case on the authority of Dr. Daniel, in which salivation was suspended for eight or nine days under an attack of remittent fever, and then returned, though no mercury had been given after the fever came on. Instances of recurrence after three and even four months are on record; but in one case, quoted by Christison, the salivation was unattended by fœtor, redness, ulceration, or sponginess of the gums. The possibility of recurrent mercurial salivation is also confirmed by analogy; for in the case referred to in the foot-note to page 483, the salivation took place after the iodide of potassium had been suspended for several weeks.

f. Gangrene of the mouth. Cases of *cancrum oris* following exhausting maladies, or occurring in children badly lodged and badly fed, are not very rare. In such cases it seldom happens that mercury in some form has not been given. Hence a difficult question as to the cause of the disease. In the absence of any exact means of discrimination, it may be sufficient to state that extreme debility, brought on by any of the causes just mentioned is a sufficient cause; and that even if the mercury which may have been given has contributed to the fatal result, the medical man is not to be blamed for the use of a medicine of great value in the diseases of children, and which less frequently causes salivation in them than in adults. It is generally stated that gangrene the effect of mercury, may be distinguished by its beginning in the mucous membrane of the mouth and throat, while the cancrum oris begins in the skin of the cheek or chin. This state

ment is without foundation; for in a fatal case of mercurial salivation that occurred under the care of Dr. John Bright, of the Westminster Hospital, the gangrene began as a small black spot between the lower lip and chin; and other like cases are on record.

2. *Mercurial Tremors, Shaking Palsy, Tremblement Métallique.*—This disease occurs more particularly in men whose work exposes them to the fumes of mercury, or causes them to handle the oxide so as to absorb it by the skin; such as quicksilver miners, water gilders, mirror silverers, and barometer makers. It may begin suddenly or come on gradually; and may or may not be attended by salivation. The upper extremities are commonly first affected, and then, by degrees, all the muscles of the body. In the worst cases, the patient can neither speak, masticate, nor walk. The unsteadiness of the arms prevents him from grasping objects, and the muscles of the legs are so convulsed that he cannot plant his foot firmly on the ground, but when he tries to walk, his gait becomes an unsteady dancing trot. In some cases, paralytic affections occur, attacking chiefly the upper extremities, like lead; but sometimes also the laryngeal muscles, causing aphonia. Psychical symptoms generally manifest themselves. The patient becomes irritable and melancholic, and sometimes demented or maniacal. If the patient does not give up his work, he loses his memory, is unable to sleep, becomes delirious, and so dies. On leaving off his work he generally gets well, but the recovery may occupy some weeks or months. Sometimes the disease is incurable. The absorption of the poison is occasionally indicated by a blue mark on the gums, as in lead poisoning, but more commonly by a dark red line; and a curious symptom not generally recognized, though often present, is a brittle state of the teeth, causing them to chip. The preventive treatment of this affection consists in cleanliness, ventilation, and a low temperature of the workshops; and the swallowing of white of egg in water three or four times a day may be recommended.

In two instances, an exposure to the vapours of mercuric methyl in course of preparation in the laboratory of a medical school, gave rise to cerebral symptoms, and death in delirium and coma after ten days, in the one who had been exposed longest (3 months) to the vapour; and in the other, exposed a shorter period, to death at the end of a year in a state of complete dementia.*

Post-mortem Appearances.—Corrosive sublimate and the soluble salts of mercury give rise to post-mortem appearances

* 'St. Bartholomew's Hosp. Rep.' 1865, i. p. 141.

intermediate between those produced by the corrosive acid poisons and by the stronger non-corrosive irritants, such as arsenic. Corrosion, softening, and sloughing ulceration of the stomach and intestines are of frequent occurrence, and the peritoneum is often inflamed. The sloughs have been found to yield mercury on analysis. Sometimes the small intestines escape, and the poison acts only on the stomach and on the rectum, or on the large intestines generally. The decomposition of the salt by contact with the mucous membrane, with the contents of the stomach, or with antidotes, and the consequent deposition of minutely divided mercury on the lining membrane, as a thin slate-coloured covering, sometimes serves to identify the poison. When the body is in a state of decay, a similar appearance may be caused by sulphuretted hydrogen, giving rise to the formation of the black sulphide. Mercurial salivation is detected by the inflamed or sloughing state of the mucous membrane of the mouth.

In poisoning with corrosive sublimate, a highly inflamed state of the urinary organs and contraction of the bladder, corresponding to the scanty secretion of urine during life, are more frequent than in poisoning with arsenic.

Intense inflammation and ulceration, and even sloughing of the cæcum and large intestines, are also more common in poisoning by corrosive sublimate than in poisoning by tartar emetic and arsenic. These appearances are probably explained by the elimination from the glands of the large intestines, of a highly irritant poison.

Corrosive sublimate applied to the mucous membrane after death hardens it, and causes it to assume a dead white, wrinkled, and granulated appearance, with rose-coloured vessels ramifying upon it. These appearances extend to the muscular and peritoneal coats. Sir B. Brodie found the same effect to be produced on the living and dead mucous membrane.

Fatal Dose.—*Three* grains have proved fatal to a child; but large doses have been swallowed with impunity, being rejected by vomiting, or decomposed by antidotes.

Fatal Period.—The shortest period on record, *half an hour*, was in a case reported by Mr. Welch to Dr. Taylor. Cases of death in two or three hours are not rare. The nitrate of mercury has proved fatal in two hours and a half. In the case of corrosive sublimate, as in that of arsenic, the period is extremely variable.*

* The following periods are on record:—one of 2 hours; one of $2\frac{1}{2}$ hours; one of 3 hours; one of 6 hours; one of 11 hours; and one of 3, 6, 8, and 11 days

Mortality.—More than half the cases.

Treatment.—The best antidote to corrosive sublimate is albumen. Gluten, or wheat flour, milk, iron filings, a mixture of gold dust and iron filings suspended in gum water, the hydrated protosulphide of iron, the carbonates of the alkalies, and meconic acid, have also been suggested. Those most readily procured are the white of egg and gluten. The white of egg should be given freely mixed with water, as long as urgent symptoms are present, accompanied, if necessary, by emetics and diluents. If eggs cannot be procured, flour mixed with water, or milk, may be substituted. White of egg has been proved to be an efficient antidote in so many cases, that where it is at hand it is unnecessary to resort to any other.

The rest of the treatment is that proper to poisoning by the irritants generally. Where salivation is present, cool air, cold drinks, and gentle aperients, with gargles of alum or common salt, must be used. Acetate of lead, recommended in ordinary medical treatment, would be objectionable in medico-legal cases.

Corrosive sublimate produces its characteristic effects in whatever way it may be introduced into the system. Death has happened through the cutaneous absorption of the poison.*

CALOMEL (*Subchloride of Mercury, Protochloride of Mercury*).

Properties.—A heavy white or yellowish-white powder, insoluble in water, alcohol, and ether, but soluble in nitric and hydrochloric acids.

Tests.—Calomel, like corrosive sublimate and arsenic, volatilizes, but as an amorphous powder, and at a temperature of 240° Fahr. Its insolubility in water distinguishes it from corrosive sublimate, but not from arsenious acid. It is turned black by sulphide of ammonium, liquor potassæ, and liquor ammoniæ. It reacts like corrosive sublimate with protochloride of tin: heated with carbonate of soda, it yields a sublimate of metallic mercury, and it gives a silvery stain when moistened with dilute muriatic acid and rubbed on copper foil.

Calomel, though generally a safe medicine, and one that may be given in many diseases in large doses often repeated, sometimes acts as a strong irritant poison, or destroys life by producing

respectively. Of these nine cases, then, about half died in less than 12 hours and the remainder in a period varying from 3 to 11 days.

The reader is referred to the following cases:—'Medical Gazette,' vii. 329; viii. 616; xxix. 797; xxxi. 556. 'Ed. Med. and Surg. Journal' (five cases, Valentine), xiv. 468; li. 114; liii. 404; lviii. 505; 'Lancet,' Feb. 1870 (Eade).

* See 'Lancet,' Sep. 16, 1871.

gangrene of the mouth and throat. Cases are on record of fatal results following a single dose of a scruple, fifteen, eight, and six grains. On the other hand, doses of three drachms, and of one ounce have been taken with impunity. In Asiatic cholera, and in the severe fevers of hot climates, calomel in repeated doses of one scruple has appeared to be beneficial.

The exceptional effects of calomel have been attributed to its partial conversion into corrosive sublimate by the free hydrochloric acid of the stomach, or by contact with chloride of sodium, or chloride of ammonium; but the quantity of corrosive sublimate formed by these reactions has been shown to be extremely small. Calomel has been found to contain the 500th of its weight of corrosive sublimate.

The other compounds and preparations of mercury possess poisonous properties; but as they are very rarely taken as poisons, a brief description of them will suffice.

Red Precipitate (red oxide of mercury).—This, mixed with lard or grease, is largely used for destroying vermin. Its crystals are small, brilliant, and of a scarlet or deep orange colour; the powder is orange-coloured. It is very heavy, insoluble in water, but soluble in warm hydrochloric acid, which converts it into corrosive sublimate. Heated in a reduction-tube it is entirely dissipated, metallic globules are sublimed, and oxygen gas given off.

Cinnabar, Vermilion (bisulphide of mercury).—Cinnabar is found in commerce as a dark red semi-crystalline mass, and Vermilion as a fine red powder. It is in use as a pigment, and has caused mercurial symptoms by being employed to colour the vulcanite setting of artificial teeth (Woodman). As thrown down from a solution of a per-salt of mercury by sulphuretted hydrogen, it is black; but, when sublimed, red. It is heavy, insoluble in water and hydrochloric acid, entirely dissipated by heat, but collects on the sides of the tube unchanged. When mixed with carbonate of soda, and heated in a reduction-tube, globules of mercury are sublimed; and on adding a mineral acid to the residue, sulphuretted hydrogen is given off, showing the presence of sulphur.

White Precipitate (ammonio-chloride of mercury).—A white heavy powder, insoluble in water, and entirely dissipated by heat. It yields with carbonate of soda a metallic sublimate. When boiled with liquor potassæ, ammonia is given off, and chloride of potassium formed, which may be detected by the nitrate of silver and bichloride of platinum tests; the yellow peroxide remains.

Turpeth Mineral (mercuric sulphate).—A heavy yellow powder, sparingly soluble in water, and yielding, when heated, a metallic

sublimate, with fumes of sulphurous acid. When boiled in a solution of potash, the yellow peroxide is thrown down, and a sulphate of potash formed, which may be identified as above.

Nitrates of Mercury (mercurous and mercuric).—These are used as escharotics, and in the arts chiefly in the preparation of skins and furs. The nitrate of mercury is in the form of white crystals, very soluble in water, and yielding a highly acid and corrosive solution. When heated, the crystals give off nitrous acid gas, and yield metallic globules. Mixed with carbonate of soda and heated, the metal is sublimed. Liquor potassæ throws down a yellow precipitate from its solution in water, leaving dilute nitric acid, readily detected by adding carbonate of potash till effervescence ceases, and so forming nitrate of potash. The subnitrate differs from the nitrate in yielding with liquor potassæ a *black* precipitate.

Bicyanide of Mercury (prussiate of mercury).—This consists of white, heavy, inodorous crystals, which have a strong metallic taste are soluble in hot and cold water, but nearly insoluble in alcohol. When heated, the crystals yield metallic mercury and cyanogen gas, recognised by the characteristic purple colour of its flame. When heated with hydrochloric acid, hydrocyanic acid is given off. The solution yields, with sulphuretted hydrogen, and sulphide of ammonium, a black precipitate, but no precipitate with liquor potassæ.

All the foregoing preparations of mercury have in rare instances been taken as poisons. Their activity is proportioned to their solubility, the soluble nitrates and the bicyanide, even in small doses, being extremely active poisons, while the white and red precipitate, turpeth mineral, and vermilion act much less powerfully. The soluble salts act as corrosives, the insoluble compounds as irritants; but both produce the specific effects of mercury. The symptoms of the bicyanide are those of poisoning by a soluble salt of mercury; the combined cyanogen not seeming to modify the action in any marked degree.

Two cases of poisoning by red precipitate occurred in the practice of Mr. A. Prince, and are reported in the 'Medical Times and Gazette,' November, 1869. In one of them, the symptoms of acute irritant poisoning were followed on the third day, (the dose being two drachms,) by violent salivation, with extensive destruction of the soft parts. But in a case related by Graham ('Brit. Med. Journ.,' April, 1869), where two drachms, of *white precipitate* were taken, the symptoms were those of a pure irritant, without any of the usual constitutional effects.

IV. LEAD AND ITS PREPARATIONS.

Acute poisoning with the salts of lead is as rare as the chronic form is common.

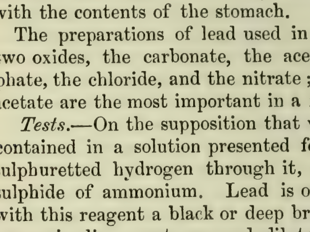
The metal itself is not poisonous; but as it is readily acted on by acids, it may impart poisonous properties to such liquids as wine, vinegar, and cider, when used (as formerly in Devonshire) in making or repairing the cyder presses. When employed to line packing cases for snuff and other commodities, it may contaminate the contents. The metal may become poisonous by combining with the contents of the stomach.

The preparations of lead used in medicine or the arts, are the two oxides, the carbonate, the acetate and subacetate, the sulphate, the chloride, and the nitrate; of which the carbonate and acetate are the most important in a medico-legal point of view.

Tests.—On the supposition that we are ignorant of the base contained in a solution presented for analysis, we first transmit sulphuretted hydrogen through it, or add a few drops of the sulphide of ammonium. Lead is one of those bases which give with this reagent a black or deep brown precipitate; and liquor ammoniæ, liquor potassæ, and dilute sulphuric acid throw down a white precipitate. By this succession of trial tests, we infer that the solution contains a salt of lead.

The base is completely identified by the following tests: 1. Chromate of potash yields a gamboge-yellow chromate of lead. 2. Iodide of potassium an iodide of lead of the same colour. 3. If a fragment of zinc the size of a pin's point be placed in a drop of the solution, the lead is quickly deposited as a "lead-tree," in one of the annexed forms.

Fig. 82.



It should be examined by the microscope before it has become obscured by the white carbonate. This test acts characteristically on one grain of the acetate of lead in four ounces of distilled water.

Oxides of Lead.—There are three oxides of lead: the protoxide, red lead, and the peroxide. The protoxide, as a yellow semi-crystalline glass, is the *litharge* of commerce; as a fine powder, it is *massicot*. A mixture of the protoxide and peroxide is the minium, or red lead, of commerce. The brown peroxide is little known out of the laboratory.

Litharge (protoxide of lead).—This is in common use by painters and glaziers. It forms a cheap glaze for the common

kinds of earthenware; and serious accidents have arisen from its being acted on by acids. Litharge has also been used to impart a sweet taste to sour wines, and it is a constituent of certain hair-dyes (p. 21). It is also used in japanning. It consists of reddish or yellowish scales, volatile at a red heat, insoluble in water, but perfectly soluble, when pure, in nitric acid, the solution having the properties of nitrate of lead. It is readily reduced on charcoal by the heat of the blow-pipe.

Minium, or Red Lead.—This is used to colour red wafers; and is sometimes mixed with snuff. It is a rich red powder insoluble in water, but partially dissolved by nitric acid. When heated, it gives off oxygen, and is reduced to the orange-yellow protoxide. It is readily reduced under the blow-pipe; and on burning the wafers that contain it, small globules of lead form on the edges, mixed with the unreduced yellow protoxide.

White Lead (ceruse, carbonate of lead).—This is largely used in the arts, chiefly as the basis of paints, and for enamel cards, and thus becomes a common cause of lead colic and of other forms of chronic poisoning by lead. It is sold in white masses, or as a heavy white powder, and has the following properties:—When heated to redness, it loses its carbonic acid, and becomes the yellow protoxide. It is insoluble in water, but soluble with effervescence in nitric acid. Though very insoluble in water, (unless when charged with free carbonic acid) it may act as a poison in large doses.

Sugar of Lead (acetate of lead).—This substance is sold as a crystalline mass resembling lump sugar; or as a glistening, heavy, white powder, very soluble in water, with a slight odour of vinegar, and a sweetish astringent taste. When heated, it dissolves in its water of crystallization, gives off some of its acid, chars, and is partly reduced to the metallic state. When heated in the mouth of a glass tube under the blow-pipe, distinct globules of lead are formed. If boiled with dilute sulphuric acid, acetic acid is given off. The powder is blackened by sulphide of ammonium, and changed to a fine yellow by iodide of potassium and chromate of potash. Its solution gives the characteristic reactions of all the soluble salts of lead.

Goulard's Extract (subacetate of lead).—This is a yellowish-white alkaline solution, distinguished from a solution of the acetate by the copious precipitate of carbonate of lead formed by transmitting a stream of carbonic acid gas through it. It is an active poison, and has more than once proved fatal.

Sulphate of Lead.—A heavy white powder, insoluble in water and in acids, unchanged by heat, and blackened by the sulphide of ammonium. Suspended in water, and exposed to the action

of sulphuretted hydrogen gas, the black sulphide is formed, the sulphuric acid remaining in the supernatant liquor, as shown by the nitrate of baryta test. Being extremely insoluble, it is stated not to be poisonous; but if given in a very large dose might not prove quite inactive.

Chloride of Lead.—A white powder, sparingly soluble in cold, but more soluble in hot water, soluble in dilute nitric acid, but insoluble in alcohol. It has a sweetish taste. At a heat below redness, it fuses into a semi-transparent horny mass (*plumbum corneum*), but is volatilized by an intense heat. Its solutions have the reactions of a salt of lead.

A yellow oxychloride of lead is used as a pigment under the name of *mineral*, or *patent yellow*, and *Turner's yellow*. Like the chloride, it is fusible, and fixed when melted.

Nitrate of Lead.—This is a crystalline salt, soluble in water. It is largely used in calico-printing, and forms the basis of Ledoyen's disinfecting fluid. When heated in a glass-tube, nitrous acid vapour is given off, and the yellow protoxide remains behind. The solution gives the characteristic reactions of a salt of lead; and filtering paper dipped in it and dried, burns like touch paper.

Detection of Lead in Water, Organic Liquids, &c.—The presence of lead in water in very small proportions is best shown by filling two tall vessels with the water, acidulating and transmitting sulphuretted hydrogen through the one. If lead is present, a brownish discolouration of the water will be caused and readily detected by looking down through the two vessels standing on a white sheet of paper.

In organic liquids and tissues the process of destruction of the organic matter by hydrochloric acid and chlorate of potash (p. 400) furnishes a liquid from which lead is precipitated as a black sulphide.

Some lead may, however, remain undissolved in the tissues after the treatment with hydrochloric acid. In such cases the solid matters may be incinerated, the ash dissolved in nitric acid, diluted, and treated with sulphuretted hydrogen, as before. Or the matters may be fused in a crucible with nitre and carbonate of soda, the fusate dissolved in water, and the lead precipitated as the carbonate by carbonic acid. The carbonate collected and washed, may be dissolved in nitric acid and tested in the usual way.

If by either or both of these processes a black precipitate is obtained, it may be proved to contain lead in two ways:—1. By placing the dried precipitate on a fragment of charcoal and reducing the metal by the blowpipe. 2. By exposing the

sulphide to a red heat in a tube of German glass open at both ends, to burn off the sulphur, treating the residue with strong nitric acid, diluting with distilled water, filtering, and evaporating to dryness. The residue, being dissolved in distilled water, will give the characteristic reactions of lead.

Quantitative Analysis.—Lead may be extracted as the sulphide if free from organic matter. 100 parts of the sulphide=86·61 lead. Or the sulphide may be treated with nitric acid, and then converted into the sulphate by the addition of sulphuric acid and further evaporation to drive off excess of acid. Of the sulphate 100 parts=68·319 lead.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—All the salts of lead, with the exception, perhaps, of the sulphate, act as weak irritant poisons, differing from other irritants chiefly in the absence of diarrhœa, and the presence of the opposite state—constipation. Even the most soluble preparations act more feebly than most metallic irritants, and are not often fatal.

The usual symptoms caused by a large dose of a soluble salt of lead are a burning and pricking pain in the throat and gullet; thirst; vomiting; colic pains with tenderness of the belly, and obstinate constipation; cramps, cold sweats, and, in fatal cases, convulsions, and tetanic spasms. In one case the pulse fell to 40. Diarrhœa is an exceptional occurrence.

The most important and interesting form of lead poisoning is that which is brought on by the long-continued use of preparations of lead, as medicine, in the arts, or in consequence of the accidental impregnation of water, beverages, or articles of food.

Chronic Lead Poisoning.—The symptoms do not always follow the same course; but generally the special affections are preceded for a time by disordered digestion and tendency to constipation. The gums become swollen and livid, and are marked by a blue line where they join the teeth. The skin is dry and the complexion cachectic. The pulse is slow and hard. One of the most characteristic phenomena of lead poisoning is the *Lead Colic*, *Painter's Colic*, or *Colica Pictonum*, so called after Poictou, the district in France where (in modern times) it was first observed. This affection is marked by excruciating pain of the abdomen, especially in the pit of the stomach and around the naval, almost always relieved by pressure. The belly is hard, the muscles of the abdomen strongly contracted, and the navel drawn inwards. The bowels are either obstinately confined or scanty

motions are passed with much suffering. Diarrhœa is rare, but vomiting frequent. The urine is scanty, and passed with difficulty. The countenance is dull and anxious, the skin bedewed with cold perspiration, the pulse is tense and hard, sometimes of the natural frequency, often abnormally slow, but occasionally accelerated. In rare cases febrile symptoms are present. The symptoms may end in recovery, or may pass into further stages. Neuralgic pains, affecting various parts of the body, such as the bones, the muscles, and skin, are of common occurrence, and tendinous swellings occasionally form on the wrist. Sometimes there is anæsthesia. Another special result of chronic lead poisoning is *Lead Palsy*. This is sometimes the termination of a single attack of colic, but more commonly it supervenes after repeated seizures. In some cases, again, it comes on without any previous attack of colic. The disease affects the extensor muscles of the forearm or muscles supplied by the musculo-spiral (with the exception of the supinator longus), so that when the arm is raised, the hand falls by its own weight. Hence the expression "dropped wrist." The paralysis is usually preceded by tremors in the affected muscles. It occasionally attacks the laryngeal muscles, and causes aphonia. The more advanced symptoms of chronic lead poisoning consist in affections of the brain and nervous system. Delirium is common, and affections of the mind either melancholic or maniacal, with violent headache and amaurosis, which may prove rapidly fatal or be recovered from.* In other cases, epileptiform convulsions occur. The progress of lead poisoning is towards death unless the sufferer is withdrawn at an early period from the influences at work. A saturnine cachexia is developed, characterized by great prostration of strength, and stooping, tottering gait, muscular atrophy, a dull earthy complexion, loss of appetite, and obstinate constipation, and death at length happens from cachectic dropsy, or from some intercurrent acute inflammatory attack. Disease of the kidneys, with albuminuria, is said to occur as a result of lead poisoning; and gout is frequently associated with it.

The persons most subject to chronic lead poisoning, are those employed at furnaces for smelting lead ore, manufacturers of litharge, and of red and white lead, house-painters, colour-makers, plumbers, and workers in lead, glass-blowers, glaziers, potters, and manufacturers of glazed cards. It occurs occasionally in persons who make comparatively little use of lead, as in compositors from the handling of the types, in fishmongers from the use of

* Bramwell 'Edin. Med. Jour.' Dec. 1879.

lead counters covered with brine.* In other cases, both in men and animals, it is traced to the use of drinking water contained in leaden pipes or cisterns, under the circumstances presently to be mentioned. In the several employments just mentioned, lead finds its way into the system either by the skin, the lungs, or the stomach.

A blue line on the gums at the margin of the teeth first described by Burton, affords a valuable indication of lead poisoning. It is rarely absent where marked symptoms of poisoning are present, and it is an important sign in cases in which it is not possible to ascertain the channel by which the lead has entered the system. It is due to the formation of a sulphide.

Post-mortem Appearances.—In a case of acute poisoning by Goulard's extract, the lower end of the gullet, the whole stomach and duodenum, part of the jejunum, and the ascending and transverse colon were greatly inflamed, and the villous coat of the stomach appeared as if macerated. The stomach contained six ounces of a reddish-brown fluid which had a sweetish, styptic, metallic taste, exhaled the odour of vinegar while evaporating, and yielded globules of lead when the dry residue was subjected to the process of reduction (Christison).

In colica pictonum there are no constant morbid appearances beyond an unusual constriction of the large intestines. In lead palsy the affected muscles are found pale and flaccid, and when the disease has been of long continuance, the striæ are lost and the muscular fibre replaced by connective tissue. Kussmaul and Maier have described as the result of long-continued poisoning by lead, an atrophic condition of the mucous membrane of the intestines and degeneration of the muscular layers. Hypertrophy of the connective tissue, and degeneration of the nervous tissue, have been observed in the ganglia of the sympathetic.

The mode in which lead acts has been the subject of much investigation, and is not as yet satisfactorily determined. Lead is deposited in all the organs of the body, quantitatively in the following order: bones, kidneys, liver, brain, muscles, intestines.

Treatment.—The antidotes to the salts of lead are the soluble alkaline or earthy sulphates, of which the sulphate of magnesia is to be preferred. These should be freely administered, dissolved, or suspended in water. If vomiting is absent, it may be excited by emetics of sulphate of zinc, and encouraged by copious draughts of warm water; or the stomach-pump may be used. Milk, and white of eggs may be given with advantage. When

* I have witnessed two or three cases among this class of tradesmen (G.).

the pains are severe, and the bowels costive, opium, combined with aperients, and copious injections of warm water, afford relief. The rest of the treatment is that proper to the irritant poisons.

The chief practical rule for the prevention of lead poisoning in workshops is the strict enforcement of cleanliness. Moist grinding has been of much service in preventing the dangers from diffusion of lead dust through the atmosphere. Flannel respirators may be worn with advantage where the dust is unavoidable, as in packing, &c. Sulphuric acid lemonade has been recommended as a prophylactic drink among the workmen.

In consequence of the extensive use of lead in pipes and cisterns for conveying and holding water, and the evil effects which may result from the action of the water upon it, it is important to examine the circumstances under which that action takes place. This subject has been carefully investigated by Christison, Taylor, and Miller. The principal results of their inquiries may be briefly stated as follows:—

The contact of air and water with the metal leads to the formation of an oxide which dissolves in the water. The solution absorbs carbonic acid from the air, and the resulting oxycarbonate is deposited in silky scales. A fresh portion of oxide is formed and dissolved, and a fresh crop of crystals deposited; and in this way the metal is rapidly corroded. The free access of air is essential to these changes, for distilled water deprived of its gases by boiling, and excluded from air, has no action on lead; while the water, whether it be distilled water, or very soft river water, or rain water collected in the open country, left in contact with pure lead, with the free access of air, causes a very rapid corrosion of the metal. On the other hand, rain water collected from the roofs of houses in large towns, in consequence of the impurities it dissolves, has little or no action on lead.

Again, the action of water on lead is greatly modified by the presence of saline substances, even in the small quantity of three or four grains to the gallon. The chlorides and nitrates promote corrosion; but the sulphates, phosphates, and carbonates obviate it. Bicarbonate of lime is a very effectual preservative; and to its presence many springs owe their property of not acting on lead. Sulphate of lime in the small proportion of one part in 5000, also affords complete protection. Some river waters (and this is true of Thames water), and most spring waters, contain sufficient saline matter to render the use of lead perfectly safe. But the waters of some rivers and springs are so destitute of saline matters as to act powerfully on lead. It must not, however, be forgotten that

the presence of carbonic acid completely counteracts the preservative effect of the salts above-mentioned. It is well, then, to forego the use of lead for cisterns and water-pipes. Slate should be used for cisterns; and iron, earthenware, or glass, for pipes.

As a general rule, then, the action of water on lead, and the consequent danger of conveying and preserving it in pipes or cisterns made of that material, varies directly as its purity, and it follows that we may render the use of lead for such purposes perfectly safe by the artificial admixture of saline matter with the purer kinds of water. Sulphuric acid, by forming an insoluble sulphate of lead, is also an efficient protection. Lead is most dangerous when it is employed to collect or preserve rain or snow-water, or spring water of unusual purity; and the danger is increased by the use of leaden lids to cisterns, the pure water rising by a natural process of distillation, and collecting on the lid.

There is another cause which greatly facilitates the action of water on lead, and may neutralize the preservative effects of saline matter, and be even intensified by its presence—namely, the galvanic action excited by the contact of some other metal, or metallic solder, with the lead.

Vegetable acids and fatty substances dissolve lead; hence the danger of keeping ascescent fruits or liquors, or fatty matters, in vessels made of the metal, or glazed with the oxide. Sour milk, cider, wine, and rum, have acquired poisonous properties in this way. Shot used for cleaning wine-bottles, and carelessly left in them, have impregnated the wine with lead.

For the elimination of lead from the system, it is usual to prescribe iodide of potassium in doses of five or ten grains three times a day. Sulphate of magnesia may be advantageously combined with it.

V. COPPER AND ITS PREPARATIONS.

Acute poisoning by copper is a rare occurrence. The marked colour of all its salts prevents accidents and discourages murderous attempts. Suicides occasionally resort to them. But the use of copper utensils in cookery has often led to the production of poisonous salts, and numerous cases of poisoning, some of which have ended fatally. When these vessels were more in use than they are now, treatises were written to warn the public of their danger.

The metal itself is not poisonous; but all its soluble salts (and notably the acetate and the salts resulting from contact with acid fruits) are: and as the metal readily oxidizes and combines with

carbonic acid, and the carbonate itself with acids, cases of contamination of solids and liquids with copper are of frequent occurrence.*

Copper also forms the chief constituent of several alloys with metals (such as tin, zinc, and lead) which themselves yield poisonous salts; and it is a fractional constituent of silver coins. Copper and brass are largely used for the manufacture of vessels, pipes, and cocks, which hold or transmit water and other liquids, and these, if not kept clean, may become the source of accidental copper poisoning; some solders also consist largely of copper. Bronze powder, which contains finely divided copper in excess, is used in the arts, handled and inhaled.

Vessels made of copper are intentionally employed (especially in France) to impart a fine green colour to peas and other vegetables boiled in them; and the sulphate of copper has been used to promote the fermentation of dough, and to decolorize sugar.

Copper, again, is not an inactive ingredient of the arsenite of copper, or Scheele's Green (see p. 462).

Coins and buttons consisting wholly or chiefly of copper are apt to be sucked or swallowed, and brass pins to be held in the mouth, and so prove poisonous.

Among the compounds or salts of copper, the hydrated peroxide the carbonate, the sulphate, and the acetates, must be briefly noticed.

The Hydrated Peroxide.—This is met with as mineral green and as verditer. Mineral green formerly consisted of arsenite of copper, but is now formed by a combination of the hydrated peroxide with pure lime or chalk, potash, and alumina. Verditer consists of the same constituents in different proportion.

The *anhydrous* peroxide is a brownish black powder, readily dissolved by nitric acid, the solution assuming, on adding ammonia in excess, a deep blue colour. The *hydrated* peroxide is formed by adding liquor potassæ to a solution of any of the soluble salts.

As none of the salts of copper assume the importance of arsenious acid or corrosive sublimate, it will suffice to consider the tests for copper generally, and then to describe and distinguish from each other those salts which are in common use.

Among the liquids which have been found to contain copper, the following may be specified:—water and soda water; some mineral and spring waters; cyder, vinegar, wine, and shrub; and catsup. Among solid matters grain, flour, and bread; pickles; preserved fruits; sweetmeats and comfits and tea. The tradesmen and mechanics most subject to copper-poisoning are dealers in old metal, engine drivers in oiling and cleaning their engines brassfounders and braziers, and workers in bronze and with bronze powders.

Tests.—The salts of copper are either blue or green. Sulphate of iron and the salts of nickel are also green, and will, therefore, have to be distinguished from the green salts of copper. In very dilute solutions the colour disappears, or is so masked as to afford no clue to the nature of the substance with which we have to deal. To detect the metal, we first test the liquid with sulphuretted hydrogen, which occasions a deep brown or black precipitate, as does the sulphide of ammonium. On adding liquor ammoniæ, the hydrated peroxide is thrown down, but redissolved on the addition of ammonia in excess, the resulting liquid having the characteristic deep blue colour of the hydrated peroxide.

The salts of copper in solution may be further identified by the following tests:—1. Ferrocyanide of potassium yields a fine hair-brown gelatinous precipitate. 2. Polished iron (a needle suspended by a thread) placed in the solution is soon coated with a thin film of the metal. 3. A drop of the solution placed on platinum foil, slightly acidulated, and touched with a strip of zinc, yields the same metallic deposit. 4. If a minute fragment of zinc is placed in a drop of a solution of a salt of copper on a flat surface of glass, the copper is deposited in an arborescent form; and distinguished by its colour.

Carbonate of Copper (natural verdigris).—This is the greenish coating formed on the surface of copper and its alloys by the action of air and water. It effervesces with acids; and the reactions of the base are those of other salts of copper.

Sulphate of Copper (blue vitriol, blue-stone, Roman vitriol).—The base may be detected by the tests already described. By adding a few drops of liquor ammoniæ, and a solution of arsenious acid, the green arsenite is thrown down. The acid in combination is detected by the nitric acid and nitrate of baryta test.

Subacetate of Copper (artificial verdigris).—This term is applied either to the unmixed subacetate, or to this blended with the neutral acetate and carbonate. Its colour is accordingly sometimes blue, sometimes green. When the subacetate is heated in a test-tube by the spirit-lamp, part of the acetic acid is given off; and the rest being decomposed, supplies carbon to deoxidize the copper; so that a film of metal is left on the side of the tube. Acetic acid is also disengaged when the salt is boiled with dilute sulphuric acid.

Nitrate of Copper.—This consists of deliquescent blue crystals. The acid in combination may be detected by the absence of a precipitate with nitrate of baryta, and with nitrate of silver; and by the ruddy fumes of nitrous acid gas evolved on boiling the crystals with tin filings in a few drops of distilled water. By

adding liquor potassæ to the solution, nitrate of potash is formed, which may be identified by appropriate tests (p. 410).

Chloride of Copper.—There is a bright green, soluble, deliquescent chloride, and a white insoluble subchloride of copper. An oxychloride is known as Brunswick Green. The tests for the base are the same as for other salts of copper. The hydrochloric acid in combination may be detected, in the case of the soluble chloride, by nitrate of silver. The insoluble subchloride must be converted into a soluble salt for the purposes of examination.

Arsenite of Copper.—See the chapter on Arsenic (p. 462).

Copper in Organic Liquids.—Solutions of copper are decomposed by several of the common contents of the stomach—such as albumen, fibrin, milk, tea, coffee, &c., and by its mucous membrane; the suboxide being thrown down. As the salt of copper is not always completely decomposed, it may be obtained in sufficient quantity for analysis by boiling with distilled water and passing the solution through a filter. The insoluble substances must be reserved for further examination. By slightly acidulating the liquid, and then passing through it a stream of sulphuretted hydrogen, the brownish-black sulphide is thrown down. This must be collected, washed, and dried; and incinerated in a glass tube, so as to free it from adherent organic matter. The sulphide may now be converted into sulphate by treating it with a few drops of nitric acid. The solution strikes the usual deep blue colour with excess of ammonia.

From the tissues, copper may be obtained in solution by heating with hydrochloric acid and chlorate of potash, according to the method described at p. 400. It may also be obtained by incinerating the organic substances. The residue contains metallic copper, and must be gently heated in equal parts of nitric acid and water. Nitrate of copper is formed, and may be identified by the usual tests.

Copper has been detected in the solid organs of the body, but more rarely in the secretions, in cases of poisoning by its salts. But it has been asserted to be a normal constituent of the animal frame, and of several vegetable substances used as food. M. Boutigny traced it to the manure used in raising those substances. Its presence as a natural constituent of the human body, though rendered doubtful by the negative results of experiments performed by Christison and Chevreul, has been since demonstrated by such competent chemists as Odling and Dupré, who have found it in the blood, tissues, and viscera of the human body, as also in those of domestic animals, and in such animal products as cheese

and even eggs, and in several grains and vegetables, in wheat, wheat-flour, and bread. As it is most unlikely that in these experiments the copper could have originated in any part of the apparatus employed, it may be assumed to be one of the constituents of animal bodies.* The quantity of the metal thus found in parts of the human body is far too minute to have a practical bearing on any medico-legal case in which a notable quantity is discovered in the blood, flesh, or viscera after death. Nor can the fact of its presence in this infinitesimal quantity be adduced as a valid reason why minute quantities existing in articles of food, either by accident or wilful adulteration, should not prove injurious. Nor again, can the curious fact that copper constitutes nearly 6 per cent. of the colouring matter of the feathers of a bird (the turaco, or plantain-eater) be taken to prove anything more than that the copper deposited in the feathers, as it circulates in minute quantities through the body of the bird, does not injuriously affect it.

Quantitative Analysis.—Use for this purpose the precipitated sulphide; digest it in nitric acid, and precipitate the oxide from the solution by potash. One hundred parts of the black oxide correspond to 312 of crystallized sulphate.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—These set in from a quarter to half an hour after swallowing the poison, with colic pains in the abdomen, nausea, eructations, vomiting of matters of a blueish or green colour, purging and cramps. Nervous symptoms, such as convulsions, palsy, tetanus, and insensibility, have been present. As in poisoning by arsenic and mercury, the symptoms are variously grouped in different cases. Jaundice is a symptom of frequent occurrence.

Post-mortem Appearances.—The mucous membrane of the stomach and intestines has been found inflamed, ulcerated, thickened, and of a green colour; and in parts apparently gangrenous. The salt of copper sometimes adheres to the surface. These appearances occasionally extend to the gullet. The intestines have been found perforated. The skin is yellow. The other post-mortem appearances are not characteristic.

Treatment.—The proper antidotes are albumen and iron filings. The first is to be preferred. The treatment consists in the free administration of the white of egg, followed by mucilaginous drinks:

* See an objection by Dr. Letheby to an analysis by Dr. Adams on this ground in 'Pharmaceutical Journal,' August 7, 1875, p. 119.

If vomiting is absent, the stomach-pump may be used. The rest of the treatment will vary with the symptoms.

Fatal Dose.—Half-an-ounce of verdigris in an adult (Niemann). A scruple of the subchloride in a child.

Fatal Period.—The salts of copper have proved speedily fatal. A girl aged sixteen months died in *four* hours after swallowing several fragments of blue stone (Taylor). But death has taken place after long intervals, such as 12, 13, 60, 72, and 78 hours.*

Accidental Poisoning by Copper.—Serious and even fatal accidents (often affecting several persons at the same time) have occurred from the use of copper vessels in cooking; as well as from the prolonged contact with such vessels of various acid liquids, and rancid greasy substances. The inmates of a monastery suffered severely from obstinate and severe colic, retching, and bilious vomiting, costiveness, flatulence, burning pain in the pit of the stomach, in the kidneys and extremities, and paralytic weakness in the arms. Gmelin traced these symptoms to the fact "that every vessel in the kitchen, the pots and pans, and even the milk pans and butter dishes for storing the butter, were made of copper." Similar accidents have happened on board ship:—to thirty-six men on board the *Cyclops* frigate, of whom three died after violent convulsions (Gordon, in Blane on Diseases of Seamen; note, p. 293 of 3rd edition) during the last voyage of Captain John Ross to the Polar regions, when the sailors ate of salmon boiled with vinegar in copper vessels, from which the tinning had worn off; and in three vessels inspected by Surgeon Ramsay (Med. Obs. and Inq. vol. ii. p. 146). In several of the cases convulsions, with strange symptoms affecting the brain and nervous system, were present in keeping with the following striking statement by Dr. Percival:—"The most dreadful convulsions I ever beheld were produced by the preparation of copper 'blue vitriol,' in a young woman who swallowed about two drachms of it in a fit of desperation." In the intervals of the fits she was perfectly rational; and she recovered. (Essays, vol. ii. p. 227.) As then the salts of copper may give rise to strong convulsions, it is reasonable to attribute those present in cases of poisoning by the arsenite of copper, in part at least, to the copper constituent of that poison.

The principal facts established in reference to the impregnation of various fluids and articles of food prepared or kept in copper vessels, are the following:—Distilled water kept in contact with

* Maschka relates a case ('Wien. Med. Wochensch.' No. 26, 1871) of suicidal poisoning by the sulphate, fatal in 3 days. Jaundice was a prominent symptom, and was attributed to fatty degeneration of the liver, as in arsenical and phosphorus poisoning.

clean copper is not impregnated with it. Solutions of several saline matters, as common salt, alum, nitre, and Epsom salts when heated in copper vessels, are found to contain the poison. Acids and fatty and oily matters, especially when rancid, act still more strongly upon them. One general principle applies to all these substances, namely, that they may be boiled in clean vessels with comparative safety, but cannot be allowed to stand in them without danger. The contact of air with the moistened copper leads to the formation of the hydrated carbonate, which is dissolved by any acid that the substance may happen to contain.

Experiments on Animals and Man.—Some animals show a tolerance of large doses of sulphate of of copper, scarcely to be expected from the figures which may be taken fairly to represent our experience in the human subject; for while the dose of that salt as stated in the British Pharmacopœia is from $\frac{1}{4}$ grain to 2 grains as an astringent, and from 5 to 10 grains as an emetic, from 15 to 60 grains may be given to dogs for considerable periods, without sensible effect. But at length they refuse food, are seized with vomiting and purging, rapidly lose flesh and soon die. This salt of copper then is a slow but sure poison to the dog. Other experiments on animals have shown that the compounds of copper with the acetic and butyric acids give rise not only to vomiting and purging, but remotely to delirium, paralysis, and disturbance of the action of the heart, and that the neutral acetate, lactate, butyrate, and malate of copper, taken by pigeons and rabbits to the amount of from $7\frac{1}{2}$ to 30 grains, caused disturbance of the breathing, muscular weakness, tremors, spasms, and fall of temperature; and death from paralysis of the heart.

As to experiments on the human subject, Rademacher has shown, in his own person, that a dose of about 4 grains of sulphate of copper taken daily for 8 months had no other effect than to create a ravenous appetite, and a painless diarrhœa; while Toussaint took from 3 to $7\frac{1}{2}$ grains of the same salt, morning and night, for 14 days, with no other symptom than a metallic taste, and after using various preparations of copper for 6 months, remained quite well.*

Chronic Poisoning by Copper.—To the continued introduction of copper into the system, various bad results are ascribed, respecting which, however, there is much difference of opinion. A 'copper colic,' similar to the colic of lead, but more frequently associated with diarrhœa, occurs among workers in copper; but while some

* For these and other interesting facts, with references, I am greatly indebted to Dr. Lauder Brunton, who forwarded them to me in 1877, when the inquiry into the adulteration of peas by copper was going on (G.).

attribute it to the copper itself, others ascribe it, at least in part, to the metals which, blended with it, make up the various alloys of brass and bronze. The leading symptoms attributed to this gradual and continuous introduction of copper into the system, are chiefly irritation of the mucous tracts (conjunctival, bronchial, and gastro-intestinal), with abdominal pain and tenderness and diarrhœa. A coloured line forms on the gums described as purple-red (Corrigan) or greenish (Clapton). A green tint has also been imparted to the hair, urine, and perspiration.* Brassfounders are occasionally attacked on melting days with acute febrile symptoms, resembling those of an intermittent, and known as "brassfounders' ague." But these symptoms have been ascribed to the zinc of the alloy.

As already stated, it is a common practice to colour pickles, capers, peas, and other vegetables with salts of copper, so as to impart a fresh green tint to them. That these products contain a very appreciable quantity of copper may be shown by immersing among them a needle moistened with acetic acid, when it will receive a coating of metallic copper. The question whether the small quantities of the acetate or other salt of copper existing in these green vegetables may injure health, was raised in the early part of the year 1877, at the instance of Dr. Conway Evans, medical officer of health to the Strand district, who alleged that the sale of the *petit pois* was a direct violation of the Sale of Food and Drugs Act, § 3. Nine specimens of these preserved peas, in which the quantity of copper ranged from little more than half a grain to more than four grains, estimated as sulphate of copper, in the pound avoirdupois, formed Dr. Evans' justification for the proceedings taken under the Act. The allegation that peas thus artificially coloured were, or might be, injurious to health, having been contested before Mr. Knox, at the Marlborough Police Court, his decision was favourable to the affirmative view; the persons who sold the peas were fined, and the practice condemned.

A full discussion of the grounds on which the decision of the court was based would be out of place here; suffice it to state that while on the one side experiments on animals and healthy men, and the experience of groups of persons working with copper or its alloys were brought forward to show that little or no injury may be occasioned by large quantities of copper entering the system (in which respect copper resembles arsenic as taken by the Styrian peasants), on the other, facts were adduced in proof of the serious and even fatal results that have followed the swallowing small quantities of the salts of copper, as contained in cupreous oint-

* Greenhow, 'Med. Times and Gaz.' vol. i. 1862.

ments applied to the lips, brass tacks held in the mouth, coins sucked or swallowed,* and of water kept in foul copper vessels.

Johnstone, after quoting Neumann as testifying to the dangerous effects that may follow the ingestion of small quantities of copper, says, "I have known the same inconveniences arise from the use of a cupreous ointment for the cure of aphthæ, and in one case the life of the child was saved with difficulty, though, from the quantity of ointment applied to the mouth, the portion of copper taken into the stomach must have been very small." Percival's case of the young lady who ate two breakfast-plates full of pickled samphire, "very strongly impregnated with copper," and died in nine days, after much suffering, the membrane of the stomach and commencement of the small intestines being found inflamed and gangrenous, might have been quoted here, but that the large quantity of pickle consumed suggests doubts of the copper having of itself proved fatal.

VI. ZINC, TIN, SILVER, IRON, BISMUTH, CHROME, AND THEIR PREPARATIONS.

ZINC.—Two preparations of zinc require notice—the sulphate and chloride.

Sulphate of Zinc, White Vitriol, White Copperas.—This is in common use as an emetic, but is unimportant as a poison. It consists of colourless, or nearly colourless, prismatic crystals, very soluble in water, and of a styptic taste; and resembles oxalic acid and sulphate of magnesia. From the former it is distinguished by tests, for which see Oxalic Acid; and from the latter by yielding a white precipitate with sulphuretted hydrogen or sulphide of ammonium, which sulphate of magnesia does not.

Sulphate of zinc in solution is precipitated as white sulphide by sulphuretted hydrogen and sulphide of ammonium, provided the solution does not contain an excess of acid; and also by liquor ammoniæ and the sesquicarbonate as a white precipitate soluble in excess of the precipitant. Ferrocyanide of potassium, too, yields a white precipitate. If the sulphate contains iron, the precipitates are not a pure white.

In Organic Liquids.—Sulphate of zinc is decomposed by albumen and milk, which form with the oxide an insoluble compound; and also by substances containing tannin. After the destruction of the organic matters with hydrochloric acid and chlorate

* And yet Dr. Paris (Paris and Fonblanque, vol. ii. p. 144) quotes, on good authority, no less than five instances in which several copper coins were swallowed and long retained without acting poisonously.

of potash, zinc is found in the acid liquid as a chloride. Sulphuretted hydrogen causes no precipitate till the acid has been neutralized by ammonia. Sulphide of zinc is precipitated, but generally coloured by iron from the tissues. The precipitate is to be treated with dilute acetic acid to dissolve any iron, &c., collected and roasted in a porcelain crucible, and converted into oxide. This is to be dissolved in sulphuric acid with the addition of hydrochloric or nitric acid, evaporated to drive off excess of sulphuric acid, and redissolved in water. A solution of sulphate of zinc is formed which is to be tested as above.

Symptoms.—Sulphate of zinc has a disagreeable bitter taste, and causes, in large doses, dryness of the throat, thirst, vomiting, purging, and pain of the abdomen. Being a strong emetic, it is, in most cases, soon rejected from the stomach; but in a case reported by Dr. Gibb, in which 67 grains contained in a lotion were swallowed by an adult female, there was no vomiting, and some difficulty in relieving the stomach by emetics. It has been administered as a medicine in doses of two scruples three times a day for several weeks, without injurious consequences (Dr. Babington).

The Post-Mortem Appearances are those of simple inflammation of the mucous membrane of the stomach and intestines.

Treatment.—A dilute solution of carbonate of potash or soda as an antidote, followed by the free administration of milk, of the white of egg in large quantity, and of liquids containing tannin such as tea, and decoctions of oak or Peruvian bark. The rest of the treatment is that common to the irritant poisons.

Chloride of Zinc.—A concentrated aqueous solution of this substance (about 200 grains to the ounce) is the disinfectant known as "Burnett's Fluid." It is a strong corrosive poison and produces the symptoms and post-mortem appearances common to the class of corrosives; sometimes with the addition of nervous symptoms. It has more than once proved fatal, and death has occurred in as little as four hours.

Tin.—*Chlorides of Tin.*—There are two chlorides of tin, the protochloride and the perchloride, in the form of yellowish-white acicular crystals. A mixture of these two salts in solution is known as *dyers' spirit.* These are the only preparations of tin which require notice.

Tests.—The *protochloride* has the following properties:—1. Sulphuretted hydrogen and sulphide of ammonium throw down a precipitate of a dark chocolate colour, soluble in excess of the reagent. 2. The bichloride of mercury gives a grey precipitate of finely divided mercury. 3. Chloride of gold gives a deep purple precipitate

(the purple of Cassius). 4. A fragment of zinc placed in a drop of the solution throws down the metal in an arborescent form, characterized though not distinguished, by the rectangular arrangements of the branches (fig. 83). One grain of the protochloride in two ounces of distilled water gives characteristic results. The acid is detected by the white precipitate, insoluble in nitric acid, caused by nitrate of silver.

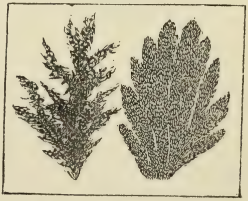
Fig. 83.

The *perchloride* is precipitated yellow by sulphuretted hydrogen, and sulphide of ammonium, the precipitate being soluble in an excess of the reagent. In colour, therefore, it resembles the sulphides of arsenic and of cadmium; but differs from the former in being insoluble in ammonia, and from the latter in being insoluble in hydrochloric acid. Corrosive sublimate and chloride of gold give no precipitate with the perchloride. The acid of the salt is detected by nitrate of silver.

The salts of tin produce the common symptoms of irritant poisoning, which must be met by the free use of albumen or milk, and of diluents. Emetics, or the stomach-pump may be employed if necessary.

Silver.—*Nitrate of Silver* (Lunar Caustic).—This substance occurs in the form of tabular crystals, or fused into small cylinders. It has the following properties:—It is very soluble in distilled water. Its solution has an acid reaction, and a strong styptic, metallic taste. It is a very powerful corrosive; and, when mixed with organic matter, is blackened by light. The base is detected by the following tests:—1. Sulphuretted hydrogen or sulphide of ammonium yields a black precipitate. 2. Liquor ammoniæ throws down the brown oxide, which is dissolved by the precipitant in excess. 3. Hydrochloric acid yields a white clotted precipitate, the chloride of silver, which is insoluble in nitric acid, and when heated on platinum-foil fuses into a horny mass. 4. On adding to the solution liquor ammoniæ, until the brown oxide is redissolved, and then arsenious acid, the yellow arsenite of silver is thrown down.

Fig. 84.



5. A strip of copper introduced into the solution is speedily coated with silver. 6. If a minute fragment of zinc is placed in a drop of the solution, the metallic silver is deposited in an arborescent form (fig. 84). This test is very delicate, a distinct tree (generally in the shape of the shaded figure) being obtained from a grain in eight ounces of water. The acid is detected by adding to the filtered liquid remaining after the application of the tests, carbonate of potash, when nitrate of potash is formed.

Poisoning by nitrate of silver is a rare occurrence. Scattergood (Brit. Med. Journ., 1871, p. 527) relates a case of fatal poisoning from the accidental slipping of a piece of caustic $\frac{3}{4}$ of an inch long down the throat of a child aged 15 months. The contents of the stomach were almost immediately rejected. Chloride of sodium was administered, but repeated vomiting and convulsions occurred during the first two hours. Then followed diarrhœa. Collapse came on, and death occurred in violent convulsions *six hours* after the poison had been swallowed.

Post-mortem Appearances.—There were erosions of the œsophagus, and of the stomach along the greater curvature, and in the duodenum and upper part of the jejunum. Particles of the curdy chloride of silver adhered to the surface. The nitrate had been entirely decomposed.

The *Treatment* consists in changing the soluble nitrate to the insoluble chloride, by the free use of a solution of common salt.

Chronic Poisoning.—After long continued medicinal administration of silver salts, a blue line appears on the gums as in lead poisoning, followed by a greyish-blue or leaden hue of the skin, of a permanent character (Argyria). This is due to the deposition of finely divided metallic silver in the cutaneous tissues. It is not, however, confined to the skin. A similar deposition takes place also in the viscera, chiefly along the walls of the smaller blood-vessels.

Iron.—The sulphate of iron (green vitriol, copperas) and the chloride or muriate of iron, possess sufficiently active properties to entitle them to rank as poisons. The base may be detected by the following tests:—1. Sulphuretted hydrogen gives no precipitate, but the sulphide of ammonium throws down a black sulphide. 2. Infusion of galls also gives a black precipitate. 3. Ferrocyanide of potassium throws down a blue precipitate, which deepens by exposure to the air. 4. Sulphocyanide of potassium gives a deep blood-red precipitate. The acid in combination in the sulphate and chloride respectively may be detected by the nitrate of baryta and nitrate of silver tests.

The *sulphate of iron,* and the *chloride* in the form of tincture,

have both proved fatal, and have in one or two other instances produced severe effects. The symptoms and post-mortem appearances in one case of poisoning by the tincture, recorded by Christison, were those of a strong irritant. The treatment would consist in the free use of emetics and diluents.

Bismuth.— *Trisnitrate, Subnitrate, or Nitrate of Bismuth.*— This substance has proved fatal in a large dose (two drachms), with the symptoms and post-mortem appearances proper to irritant poisoning. As bismuth frequently contains arsenic as an impurity, there is reason to believe that the irritant symptoms are largely due to this. It is found in the form of a white, insoluble powder, blackened by sulphuretted hydrogen, and sulphide of ammonium; soluble in nitric acid, but again thrown down when the solution is largely diluted with water. The solution resembles that of the salts of lead in being precipitated white by liquor ammoniæ and liquor potassæ, but differs from them inasmuch as it gives no precipitate with dilute sulphuric acid. It gives a deep-brown precipitate with iodide of potassium.

Chrome.—Two salts of chrome—the neutral chromate, and the bichromate of potash—are manufactured on a large scale and extensively used as dyes. The *chromate of potash* has a bright yellow colour, and disagreeable bitter taste. It is the common source of the other compounds of chrome. The *bichromate of potash*, known also as *red chromate*, is much used as a dye. It consists of deep orange-coloured crystalline plates, or long

Fig. 85.

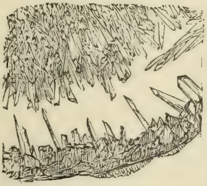


Fig. 86.

flattened prisms. It is very soluble, and yields, according to quantity, a rich orange or a yellow solution, with an acid reaction. With the salts of lead it gives a yellow, and with those of silver a deep-red precipitate. Experiments on animals show that it has the properties of a strong irritant poison; and it has more than once proved fatal to man. In one case, communicated to Dr. Taylor by Mr. Wood of St. Bartholomew's Hospital, two drachms killed a woman in four hours, with symptoms of violent

irritation, and the post-mortem appearances of a corrosive poison. The appropriate treatment would be by diluents and demulcents. In solutions of moderate strength the bichromate assumes the forms shown in fig. 85. In dilute solutions ($\frac{1}{100}$) it takes on the arborescent form shown in fig. 86. The crystals from strong solutions are coarse square plates and flattened prisms. The crystalline form of the weaker solution is important, inasmuch as it constitutes a very valuable test for strychnia and some other alkaloids.

Workmen engaged in the manufacture of the bichromate of potash suffer much from chronic sores on the hand, and occasionally on the feet and shoulders. The foundation for the sores is laid in some lesion of the skin, on which the poison acts as a caustic, producing a tough slough, followed by an ulcer with hardened cup-like border. Attacks of conjunctivitis are also of not uncommon occurrence, and more serious results occasionally follow from the introduction between the lids of the strong solution. I am indebted for this information to Dr. Eadie, of Glasgow (G.).

Thallium.—It will suffice to mention the salts of this metal as having been proved, by experiments on animals, to have a poisonous action.

The salts of the rarer metals, gold, platinum, palladium, &c., are also poisonous, but they have little medico-legal importance. Osmic acid, used largely as a staining agent in microscopical investigations, gives off highly irritating vapours, and one case of death has been ascribed to it. (Raymond, Prog. Med., June 27, 1874.)

CHAPTER IX.

NARCOTICS.

OPIUM AND ITS PREPARATIONS.

THE *inorganic poisons* have been treated of in five successive chapters, the remainder of this work will be devoted to the *organic poisons*, beginning with the most important of their number, opium. More than half the deaths by poisons which occur in England and Wales, one year with another, are due to opium and its preparations, of which laudanum holds the first place, then opium itself, then a preparation known as Godfrey's cordial, and much given to infants and young children, of whom nearly half were under one year of age. Deaths by morphia and its salts are only of occasional occurrence. It is not often that opium and its preparations are resorted to by the murderer; but they are sometimes given, laudanum especially, to facilitate the commission of other crimes, such as theft and rape; the taste and colour being generally concealed in brandy or coffee, and the sense of taste deadened by intoxicating liquors. A salt of morphia (the acetate) has been administered in several instances to complete the work prepared by repeated doses of tartar emetic. A few cases have also occurred of mixed poisoning by laudanum and prussic acid.

The *capsules* of the Papaver somniferum (white, or garden poppy) (fig. 87) furnish several preparations to the British Pharmacopœia—a decoction for external use, a syrup given chiefly to infants, and an aqueous extract (extractum papaveris), in addition to the inspissated juice known as opium. A decoction of the capsules, or poppy heads, not authorized by the Pharmacopœia, is sometimes given to infants with fatal effect. As the seeds from the capsules have been found in the stomach, and as the seeds taken by themselves are alleged to have proved fatal in some instances abroad, their size and microscopic character are shown in fig. 45, p. 394. They weigh about 230 to the grain. Some are white, others grey.

Opium, the inspissated juice of the unripe capsules, has the following familiar properties:—It is of a reddish-brown colour, of a strong and peculiar odour, and has a bitter and rather acrid taste. Different specimens of the drug vary in physical properties, and in activity, with the place and year of growth, the maturity of the capsules, the greater or less care bestowed on the manufacture, and the presence or absence of adulteration. The drug consists of a number of distinct principles combined with a peculiar acid, and mixed with resin and extractive matter. These principles are dissolved by water at ordinary temperatures, by alcohol, and by mineral and vegetable acids.

Fig. 87.

The preparations of opium in the British Pharmacopœia are:—The tincture, or *Laudanum*, which contains one grain in about fifteen minims; the ammoniated tincture (five grains to the ounce); the compound tincture of camphor, or *Paregoric* (one grain in the half ounce); the extract and liquid extract of opium; the compound powder, of which one-tenth part is opium; the confection (about one grain in forty); the compound ipecacuanha, or Dover's powder (one grain in ten); the aromatic powder of chalk and opium (one grain in forty); and the compound kino powder (one grain in twenty); the compound soap pill (one part in five); the lead and opium pill (one part in eight); the ipecacuanha and squill pill (one part in sixteen and a half); and the opium lozenges, which have $\frac{1}{10}$ grain of the extract in each. The vinum opii (twenty-two grains of the extract to the ounce); the enema opii (thirty drops of the tincture in ℥ij of starch); the emplastrum opii (one in ten); the unguentum gallæ c. opio (gr. thirty-two to ℥j); complete the long list of pharmacopœial preparations which contain opium.

The *black drop*, said to contain two, three, or four times as much opium as the tincture, and Battley's liquor opii sedativus, of which twenty drops are said to be equal to thirty of laudanum, are also in common use. The first is made with verjuice and aromatics, the second is believed to be an aqueous solution. Godfrey's cordial, Dalby's carminative, children's quietness, and

several mixtures improperly given to children to procure sleep, contain laudanum, in variable quantity, as their chief ingredient, in combination with syrups, stomachics, and magnesia.

Opium contains several active principles. Morphia, narcotine, narceine, meconine or opianyl, thebain or paramorphia, codeine, papaverine, and cryptopia, have been separated; but the most important, in a medico-legal point of view, are *morphia* and *meconic acid*, combined in opium as *meconate of morphia*. Opium may be recognised by the reactions of these two substances, as well as by its odour and other physical properties.

The morphia and meconic acid are thus extracted and sepa-·ated:—The opium is infused in successive portions of cold water. This aqueous solution, holding the active principles of the drug lissolved, is boiled with magnesia, which combines with the neconic acid and carries down with it the active principles. This nixed precipitate is washed and dried, and boiled with proof pirit, which dissolves the narcotine and resin, leaving the morphia nd meconate of magnesia behind.

To separate the *morphia*, the precipitate is boiled in strong lcohol, which dissolves it mixed with resin. From this solution ure morphia may be obtained by repeated crystallization.

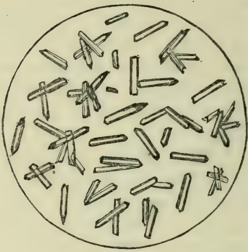
To separate the *meconic acid*, the impure meconate of mag-esia is boiled in dilute sulphuric acid, and the mixture partially vaporated. The sediment that falls on cooling is dissolved in ater, and acetate of lead added. A meconate of lead is thus rmed, which is washed and suspended in water, and a stream of ılphuretted hydrogen gas transmitted through it. Sulphide of ad is thrown down, and meconic acid left in solution; and on aporation, impure scaly crystals of the acid are obtained.

TESTS FOR MORPHIA AND MECONIC ACID.

MORPHIA (*Properties*) :—1. It is sold as a white powder, or crystals, which are generally more or less discoloured by sin; but when quite pure are colourless. They are six-sided isms; and crystals, or fragments of crystals, of this shape ıy be recognised in good specimens of the alkaloid. When rown down from a solution of one of its salts (*e.g.*, the acetate) exposure to the vapours of ammonia, it assumes the forms ›wn in fig. 88. 2. They have a bitter taste, but no odour. When heated on platinum foil, they melt into a yellow oily uid, and burn like a resin, leaving a carbonaceous deposit of a ıi-crystalline appearance, and giving out ammonia. 4. When ıted on a porcelain slab, they yield a crystalline sublimate sently to be described. 5. They are very sparingly soluble

in water and in ether, more so in alcohol, alcoholic ether, acetic ether, and amylic alcohol (readily so on heating); soluble also in the caustic alkalies, and in the mineral and vegetable acids, combined with which they are used in medicine. 6. The solution has a slight alkaline reaction. 7. In common with other alkaloids, morphia is precipitated from its solutions by tannin, and the various reagents mentioned above (p. 397).

Fig. 88.



Tests.—These are best applied to morphia in *substance ;* so that when it is present in a solution of its salts, drops of the solution on glass disks or porcelain slabs, should be exposed to the vapours of ammonia, so as to liberate the alkaloid itself.

1. *In Substance.*—If we have reason to believe that a white powder, or a colourless or straw-coloured crystal, belongs to the class of alkaloids, we confirm the suspicion by heating it on a clean slab of white porcelain, with glass slide superimposed (fig. 60, p. 443). The substance darkens, melts, smokes, deposits a black stain, and yields a sublimate presently to be described. The powder or crystal is therefore probably an alkaloid. If, now, we place a small quantity of the powder on a clean porcelain slab and dissolve it in a drop of strong sulphuric acid, it undergoes no change of colour, but turns to a light brown when warmed, and dark brown when heated. If the heat is continued, the liquid becomes almost black, and gives off an abundant irritating vapour, having an odour as of singed cloth. This reaction confirms the effect of heat, and we now prove the powder to be morphia by the following tests, applied as before on a clean slab of white porcelain:—

1. *Nitric Acid.*—This dropped on the alkaloid gives it a rich orange colour, and dissolves it with effervescence, and the production of ruddy fumes of nitrous acid.

2. *Perchloride of Iron.*—This test (which should be neutral) strikes with the powder a rich indigo-blue, turning to green when added in excess.

3. *Iodic Acid.*—Dissolve a small quantity of the acid in a drop of cold, freshly-made starch, place it on the white slab, and introduce the powder or crystal. Iodine is set free, and produces the characteristic blue iodide of farina. Or introduce the

iodic acid solution into a test-tube with a few drops of bisulphide of carbon or chloroform and shake it. The solution should remain colourless. Add a crystal of morphia. Iodine is set free, and on shaking and allowing it to subside, a rose-coloured solution of iodine sinks to the bottom.

4. *Sulphuric Acid and Nitric Acid* (Husemann's test).—Heat the crystal with strong sulphuric acid on a porcelain lid, and then on cooling add a drop of dilute nitric acid. The liquid becomes blood-red.

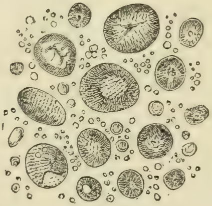
5. *Sulpho-Molybdic Acid* (Fröhde's reagent).—A freshly prepared solution of molybdic acid or molybdate of soda in strong sulphuric acid (heated till it becomes colourless) gives with morphia a beautiful violet, passing into blue and then dirty green. The blue colour is instantly discharged by the addition of water. This test is very delicate but not of itself conclusive.

6.—*Sulphuric Acid and Bichromate of Potash.*—Cold, strong sulphuric acid added to morphia, produces, as just stated, little or no effect; but on adding a solution of bichromate of potash, the mixture assumes a rich brown tint, passing rapidly to green, due to the reduction of the oxide of chromium.

Sublimates of Morphia.—Morphia sublimes at the high tem-

Fig. 89.

Fig. 90.

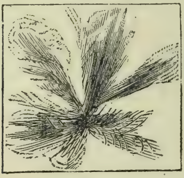


perature of 330°, melts when the heat is raised to 340°, and still continues to yield sublimates till it is reduced to a black spot of carbon. The sublimate often assumes the form of foliated curved lines as in fig. 89, or it consists wholly of white circular spots, obviously crystalline (fig. 90). But when the temperature of the glass disk approaches that of the surface of porcelain, the sublimates consist of prismatic crystals, distinct or grouped as in fig. 88. At lower temperatures they are made up of distinct striated globules or watered patterns, and sometimes they contain dark feathery crystals. The striated globules are shown in fig. 90. The best results are obtained with quan-

tities of the alkaloid not exceeding the one-hundredth of a grain, which will yield many successive sublimates characteristic in their form and reactions. These, whatever shape they assume, are highly soluble in several reagents, and yield with them crystals of very beautiful and characteristic forms.

The figures annexed represent four of these forms. Fig. 91 shows a marginal group of needles from a sublimate treated with

Fig. 91.



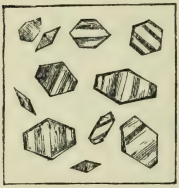
× 15.

Fig. 92.

× 50.

dilute hydrochloric acid ($\frac{1}{20}$). Fig. 92 shows the reaction with spirits of wine; fig. 93 that with liq. ammoniæ, and fig. 94 the

Fig. 93.



× 75.

Fig. 94.

× 50.

winged (fly like) crystals often resulting from the treatment of an amorphous sublimate with distilled water. These reactions should be watched as they occur, under the microscope. They are almost always quick in showing themselves, and are sometimes instantaneous.

Meconic Acid.—This consists of scaly crystals, which when impure, are dusky red; when purer, a pale yellow; when quite pure, colourless. Under the microscope they are seen as mottled plates of various sizes, shapes and thickness. They are soluble in water, and the solution has a strong acid reaction. When heated on white porcelain, they readily melt, and assume the

form of coarse white plates, and under a greater heat darken, smoke, and melt, yielding a white amorphous sublimate, and leaving a scanty black deposit. The acid is thrown down from its solutions by acetate of lead as a white meconate, insoluble in acetic acid. This substance is not poisonous. The only test of any value for meconic acid, whether in crystals or in solution, is also one of the tests for morphia, viz:—

Perchloride of Iron.—This strikes with meconic acid an intense cherry-red colour, discharged by solution of protochloride of tin, but not by the dilute mineral acids, or by the solutions of bichloride of mercury and chloride of gold.

The test gives a similar reaction with sulphocyanide of potassium, with saliva which contains that salt, and with common mustard in solution, but the colour is discharged by corrosive sublimate. A similar red colour is also struck by perchloride of iron in strong solutions of acetic acid and the neutral acetates, but, unlike meconic acid, these give no precipitate with acetate of lead, so that fact does not constitute any objection to the test for meconic acid when obtained from a solution of opium by the process described below.

This test for meconic acid strongly confirms the tests for morphia, as evidence of the presence of opium in the liquid from which they were both obtained.

Opium in Organic Mixtures.—The presence of opium in an organic mixture may be inferred from its yielding with nitric acid the orange colour due to the presence of morphia, and with perchloride of iron the red colour due to the meconic acid. These indications may be obtained by diluting the organic liquid till its colour is such as not to interfere with the reactions.

The process for the separation of the opium alkaloids from organic mixtures is that already described (p. 396). Morphia is the chief, and exists in largest amount, but narcotin, which is next in order, may also be looked for. Narcotin, as already indicated, is taken up by ether from alkaline solutions. Morphia is extracted by amylic alcohol. In the case of opium, however, it is advisable to search for meconic acid as well as morphia. With this view, the acidulated alcoholic extract of the organic matters is to be treated with a solution of acetate of lead so long as any precipitate falls. The liquid is then to be well shaken, and after standing for a time, thrown on a wet filter. An impure meconate of lead remains on the filter, while the fluid part contains the morphia as acetate, with free acetate of lead. The precipitated impure meconate of lead, suspended in a little distilled water, is now treated with excess of sulphuretted hydrogen; sulphide of lead

is formed, and meconic acid remains in solution. This solution is changed to a dark red colour by perchloride of iron; and, being concentrated by evaporation, yields crystals of meconic acid. The fluid part which contains the acetate of morphia is next to be treated with sulphuretted hydrogen, and any lead it may contain thrown down as sulphide. The liquid must again be filtered, and being reduced by evaporation to the consistence of a syrup, is to be over-saturated with carbonate of soda, and shaken up with ether. This will dissolve narcotin and various other opium alkaloids if present, while the morphia will remain undissolved. On shaking the liquid with alcoholic ether, acetic ether, or amylic alcohol, the morphia will be taken up and obtained on evaporation. If not sufficiently pure, it may be purified in the manner already described (p. 398).

Narcotin, which is soluble in ether, when set free by carbonate of soda, crystallizes in transparent rhombic prisms or needles. It is almost insoluble in water, but unlike morphia readily soluble in ether and benzine. Its salts are uncrystallizable, and are easily dissolved in water and alcohol.

It does not give the reactions characteristic of morphia with perchloride of iron or iodic acid. Concentrated sulphuric acid forms with it a solution, at first colourless but rapidly turning yellow. If this is treated with a drop of nitric acid, or a crystal of nitrate of potash, it becomes of a deep blood red. (In this it resembles morphia.)

Bloxam gives the following test:—If narcotin is dissolved in dilute hydrochloric acid, and a little solution of bromine added, a yellow precipitate falls, unless the solution is very dilute. On boiling the liquid, the precipitate is dissolved; and, by gradually adding solution of bromine and boiling, a fine rose colour is produed, even in very dilute solutions. Excess of bromine destroys the colour.

Though this method of procedure will often furnish good evidence both of morphia and meconic acid, it sometimes fails. Indeed large quantities of the fluid preparations of opium may be taken, and yet be detected neither by odour, taste, nor chemical tests, even when death takes place most rapidly; and it is now well understood that, in cases of poisoning with opium, the best methods of analysis will often fail in procuring satisfactory evidence, or even any evidence at all, of the existence of the poison in the contents of the stomach. Even the odour has been absent in the liquor removed half an hour after an ounce and a half of laudanum had been taken on an empty stomach, and when present it may be so mixed up with other odours, that

it cannot be recognised with certainty. (Bright's Reports of Medical Cases, ii. 203).

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—There is much difference in the symptoms present in different cases of poisoning by opium, and at different stages of the action of the drug.

The symptoms due to a poisonous dose of opium, or its preparations, are giddiness, drowsiness, and listlessness, followed by stupor, passing by degrees into complete insensibility. The patient lies as if in profound sleep, breathing slowly and almost imperceptibly, with eyes shut, pupils contracted and insensible to light, pulse either very frequent, or full and slow, the skin warm and moist, and the face flushed. At first the patient can be easily roused by loud noises, sudden movements, or slight blows; but, in a more advanced stage, he is kept awake with great difficulty, by violent shaking, loud speaking, tickling the nostrils, injecting water into the ear, or flecking the hands and feet with a towel. At length he falls into a state of complete coma, from which he cannot be roused, with stertor, slow and noisy respiration, a slow full pulse, a pale and ghastly countenance, cold and damp skin, and livid hands and lips. Nausea and vomiting are sometimes present from the first, but in other cases they are among the early signs of recovery. When the patient is kept roused by being briskly moved about, he is subject to constant retching, even though no emetic has been given. The bowels are generally confined. In fatal cases death may take place from apoplexy, in a state of collapse, from asphyxia, in convulsions, or in a palsied state. In patients who recover, a long deep sleep, with a remarkably slow breathing, is followed by a stage of painful nervous excitement, with headache, and distressing nausea. I have counted six respirations with a pulse of 80 in a female slowly recovering from a large dose of laudanum (G.).

Occasional Symptoms. — Spontaneous vomiting, diarrhœa, diuresis, delirium, convulsions (most common in children), sometimes alternating with stupor, locked-jaw, and tetanic spasms, paralysis, anæsthesia, dilated pupils, or one pupil dilated the other contracted, and the reflex function active and easily excited, though the patient is otherwise quite insensible. The *pulse* sometimes nearly natural in frequency and force; in other cases full and quick, but this chiefly in the first stage. In the stage of insensibility, while the patient can still be roused, the pulse is generally full and slow, but towards the fatal termination it becomes

small, frequent, and irregular. Towards the end also the pupils frequently become dilated. The respiration is much more uniformly affected than the pulse. Itching and dryness of the skin and exanthematous eruptions, are also among the occasional symptoms.

Anomalous Cases.—An absence of the usual narcotic symptoms, with sudden death. A long postponement of the symptoms. Recovery for a time; with fatal relapse.

Diagnosis from Apoplexy.—The coma of opium poisoning may be confounded with that arising from cerebral hæmorrhage, and the diagnosis from symptoms alone is not always easy, and, in some cases impossible. If the history of the case is known, much less difficulty is experienced. But if a person is found lying insensible, and there are no extraneous sources of information, great care has to be exercised in forming an opinion. If the person can be roused, the case is not one of cerebral hæmorrhage. The occurrence of one-sided convulsions or muscular spasms, or of hemiplegia, will indicate cerebral hæmorrhage. The pupils are usually but not always contracted in opium poisoning, and unequal in cerebral hæmorrhage. In some rare cases of opium poisoning, the pupils may be unequal, and in one form of cerebral hæmorrhage the pupils are contracted. This occurs when the effusion is into the pons Varolii. In this condition there may be complete insensibility, contracted pupils, and total muscular flaccidity, and no means of ascertaining whether a condition of paralysis exists. In such cases, diagnosis from symptoms alone is impossible, and other circumstantial evidence, the odour of the breath, the use of the stomach-pump, the testing of the urine for albumen, or the evidence of post-mortem examination, is required before a trustworthy conclusion can be arrived at.

Post-mortem Appearances.—These are neither constant nor well-marked. The most common is turgescence of the vessels of the brain, with or without serous effusion under the arachnoid, into the ventricles, at the base, and around the spinal cord; very rarely accompanied by extravasation of blood. The stomach and intestines are generally healthy. Lividity of the skin, congestion of the lungs, a fluid state of the blood, and early putrefaction are among the less constant appearances. The bladder is generally full, and morphia may be detected in the urine.

First Appearance of Symptoms.—The poison, when taken in large quantity, and in a fluid state, may begin to act within a few minutes, and coma may be fully formed in half an hour. Even when taken in the solid form, complete stupor has been present in as little as fifteen minutes. Sometimes, however, the action of even a large dose of the poison is postponed for half an hour, an

hour, or an hour and a half; and cases are on record in which large quantities of the poison have not produced any serious effect till the lapse of 3, 5, 9, 10, and even 18 hours. A curious case of this kind was published in the 'Lancet,' July 15, 1857, by Dr. Gibbs. Twelve drachms of laudanum were spontaneously rejected from the stomach at the end of nine hours, without having given rise to any marked symptoms. The patient was a little exhausted, and the pupils were contracted.

The action of the poison is more prompt when taken on an empty stomach than on a full stomach; when in a liquid state than when swallowed in the solid form; when the patient remains still than when he takes exercise; and it is probable that the action is postponed and diminished by spirituous liquors.

Fatal Period.—*Shortest*, three-quarters of an hour. Cases of death in about *two* hours are not uncommon; few cases are prolonged beyond *twenty-four*, and the *average* may be stated at from *seven* to *twelve* hours. When a patient survives *twelve* hours there is good hope of recovery.

Fatal Dose.—Smallest, about four grains. A quantity of the extract equivalent to four grains of opium has destroyed life. Enormous quantities have been taken with impunity. In one instance recovery took place after no less than eight ounces.

In very young children very small doses may produce marked effects, and have proved fatal. An eighth of a grain of opium, or its equivalent, has killed an infant two days old, a sixth of a grain one of four, and another of five days, a fifth of a grain, one of three days old, a third of a grain one of nine months, and another a few weeks old, a fourth of a grain a child of fourteen months, less than half a grain a child of four years and a half. Two drops of laudanum killed an infant. Severe symptoms have been produced by a single grain of Dover's powder, containing a tenth of a grain of opium. A child of four months, and several infants, have suffered severely from quantities of laudanum equivalent to the sixth of a grain of opium.

Death has happened, in the instances referred to, in intervals of time varying from 7 to 18 hours. As in the adult, so in infants and young children, recovery has taken place after considerable doses of opium. In a case under my own observation, a child of six months recovered from ten grains of Dover's powder (G).

There are some persons on whom small doses of opium and its preparations produce unusually severe effects. On the other hand, the habit of taking opium lessens its effects.

The Opium Habit.—Opium, like tobacco, may be taken in constantly increasing doses with impunity. Thirty, and even

one hundred grains, of solid opium are often taken in the day by opium-eaters; and De Quincey, the English opium-eater, brought himself to take nine ounces of laudanum, equivalent to 333 grains of solid opium, in the day. Mr. Image, of Bury St. Edmunds, has given the particulars of two cases that came under his observation, in which the enormous quantity of sixteen ounces of laudanum per diem was consumed. Yet both these persons lived to an advanced age. There is scarcely a druggist in London who has not seen laudanum swallowed by the wineglassful; and I am informed that the Lascar beggars purchase half an ounce of opium a day, from which they procure a watery extract to smoke with tobacco (G).

Opium, thus taken habitually in large quantities, and for long periods, causes emaciation and loss of vigour, loss of appetite, and constipation, loss of mental vigour, severe neuralgic pains, premature old age, and early death. Hobhouse describes the opium-eaters of Constantinople as "pale, emaciated, and rickety, sunk into a profound stupor, or agitated by the grimaces of delirium." Mr. Madden and Dr. Oppenheim confirm this account. The former adds, that a regular opium-eater seldom lives beyond thirty years, if he commences the practice early; and the latter tells us that such persons seldom attain the age of forty.

In the face of these statements, and of the extreme improbability that a habit so unnatural shouid not affect the duration of life, it has been denied that the practice of opium-eating tends to shorten it. There is no doubt that many persons who indulge in it (but in a less degree than in the cases referred to by Hobhouse, Madden, and Oppenheim) live to a good age; but it is probably with opium as with spirits and tobacco—those who indulge in them and live long would attain a much greater age if their habits of life were other than they are,* and that we hear of the few long-livers, not of the many who die young.

Opium applied to the skin, and especially to an abraded surface, used as an injection, or introduced into the nostril or ear, may produce dangerous or fatal results. M. Tournon, of Bordeaux, relates a case in which death was attributed to four grains of opium introduced into the ear.

Treatment.—The treatment must begin with the use of the stomach-pump, and warm water should be freely injected and withdrawn till it is discharged without odour and colour. If the stomach-pump cannot be immediately applied, an emetic of sulphate of zinc should be given; or, if this is not at hand, a table-

* For cases, see Christison on the case of the Earl of Mar, p. 661.

spoonful of mustard, mixed with water. At the same time vomiting should be encouraged by the free use of warm water, and by tickling the throat with a feather. If the patient is comatose, cold water should be freely dashed over the face, head, and neck, till he is somewhat roused from the stupor, and he must then be kept awake by causing him to walk rapidly between two assistants, shaking him and shouting to him. In small apartments he may be kept roused by flecking the hands and feet with a towel. When he begins to recover, strong coffee* should be freely given. If emetics by the mouth do not act, they may be injected into the bowels, and, in hopeless cases, a solution of tartar emetic might be introduced into a vein. A current of magneto-electricity passed from the spine through the chest, and artificial respiration, have been used in extreme cases. When the symptoms present are those of collapse, ammonia may be freely given internally, and applied to the nostrils; when those of asphyxia, warmth and friction to the surface are indicated; when those of cerebral congestion, the moderate abstraction of blood by leeches. In the excited state which follows recovery, as well as in the early stage, cold affusion has been practised with excellent effect.

Some of the reagents which precipitate morphia from its solutions have been proposed as antidotes. Orfila recommended tannic acid, and solutions of iodine and bromine have been suggested. The proposal to administer iodine in dilute solution has been revived by Dr. Fuller. ('Lancet,' March 21, 1868.)

As narcotism (the common effect of opium) and delirium (the leading symptoms of belladonna poisoning) are strongly contrasted conditions, it was inferred that the one poison would prove an antidote for the other. Accordingly, two American physicians, Drs. Horton and Norris, have published cases of recovery from poisoning by opium which seemed to be due to the use of belladonna, and of poisoning by belladonna thought to be equally due to the employment of opium. Dr. John Harley concluded from his experiments that morphia and atropia, so far from exercising an antagonistic influence on each other, increase each other's effects. On the other hand, numerous cases have been lately reported which seem to show that the subcutaneous injection of atropia has proved beneficial, and that within certain limits the two substances exert a physiological antagonism. Dr. J. Johnston†

* The Edin. committee on the antagonism of medicines, observed the beneficial results of the administration of caffein to animals poisoned by morphia.

† ('Med. Times and Gaz.,' Sept. 7, 1872, and Feb. 15, 1873.) On this subject the reader may refer to the following:—A case of successful antagonism reported by Dr. Wilson, of Philadelphia ('Lancet,' 1861, i. 437); a similar case by Dr.

has recorded the particulars of 16 cases of profound opium coma treated by the subcutaneous injection of atropia. Of these, ten recovered. He recommends the injection of half a grain of atropia, to be repeated in two hours if the pupils do not dilate and the respiration improve. If the coma is not so profound, a smaller dose, a quarter of a grain, may be commenced with. As the result of this treatment the pupils dilate, the face flushes, the respiration loses its stertor, the pulse improves, and after a tranquil sleep the patient recovers. Having seen 300 cases of poisoning by opium, he is of opinion that the cases of recovery under the atropia treatment would otherwise have proved fatal.

MORPHIA AND ITS SALTS.

Of this alkaloid, found in opium in proportions varying from 2 to 28 per cent., the best kinds averaging about ten, there are two salts—the acetate and hydrochlorate—which supply preparations to the British Pharmacopœia, namely, the liquor morphiæ acetatis and the liquor morphiæ hydrochloratis, which contain one grain in 2 drachms. Also the suppository, which contains half a grain of the hydrochlorate; and the morphia lozenge, as well as the compound lozenge of morphia and ipecacuanha, containing in each lozenge the 36th of a grain. The hydrochlorate is the preparation in most common use, and its ordinary dose for an adult is an eighth of a grain. The acetate is sold as a snow-white powder, or imperfectly formed crystals; and the hydrochlorate either as a white powder, or in the form of silky acicular crystals. A solution of the acetate for hypodermic injection is officinal. These salts have the chemical reactions of morphia itself.

Symptoms.—Those of opium and its preparations; but they set in somewhat earlier, and contraction of the pupils, with great dimness of vision or actual blindness, is very constant. Intense itching of the skin is also very common, and dysuria, tetanic spasms, and strong convulsions are occasional symptoms.

Anomalous Cases.—In one case reported by Dr. Shearman,*

Carter ('Phil. Med. Times,' 1871, p. 277); a case of antagonism reported by Dr. Finny (' Dublin Journ. Med. Sc.,' 1872, p. 38); one by Fothergill ('Brit. Med. Journ.' Feb. 23, 1878); and reports of similar treatment in 'London Med. Rec.,' 1873, p. 218, and 827. The researches of Little (' Phil. Med. and Surg. Rep.' xxiv. p. 334); Reese ('Amer. Journ. Med. Sc.' lxi. p. 133); and Fraser (' Trans. Roy. Soc. Edin.,' 1872, xxvi.); and 'The Antagonism of Medicines,' (edited by Dr. Hughes Bennett), 1875, on the physiological antagonism of poisons are deserving of study.[1]

* ' Med. Times and Gazette,' March 7, 1857.

[1] See an abstract of Dr. Harley's Lectures in the ' Pharmaceutical Journal,' April, 1868, p. 471.

a grain and a half of the acetate of morphia in divided doses, caused twitching of the limbs and face, difficulty in swallowing, spasms of the arms, legs, and abdomen, partial opisthotonos, and great activity of the reflex function. Morphia was found in the urine. The patient recovered. A similar case of poisoning by twenty-two grains of the hydrochlorate of morphia, in which locked-jaw, tension of the abdomen, and occasional convulsions, were present, is cited by Christison from Orfila. In one case, also, delirium followed its application to a blistered surface.

It is worthy of observation that Auguste Ballet, the presumed victim of Castaing, had, in addition to vomiting and purging, convulsions, locked-jaw, rigid spasms of the neck and abdomen, inability to swallow, loss of sensibility in the legs, contracted pupils, and stertorous breathing; and that Castaing, who prescribed for Ballet, and gave him food and medicine, was proved to have recently purchased twelve grains of tartar emetic, and twenty-six grains of acetate of morphia.*

Chronic Morphinism.—Morphia, like opium, is habitually taken by many individuals, either by the mouth or by subcutaneous injection, a habit which is often first established by the use of the syringe to relieve some painful ailment.

The chronic morphinist becomes, like the opium-eater, a miserable wreck, physically and mentally. If the accustomed drug is withheld, he not unfrequently exhibits dangerous maniacal symptoms. Levinstein † describes certain febrile affections of the intermittent or typhoid type, to which the morphinist is liable. The amount taken daily varies much, but Obersteiner ‡ places the limit at about 3·5 grammes. Beyond this there is danger of acute morphia poisoning.

Fatal Dose.—In the case of this, as of most active poisons, large doses have been taken with impunity, and small ones, in certain states of system, have given rise to dangerous symptoms. Half a grain of the acetate of morphia administered as

* John Parsons Cook, the victim of William Palmer, took pills containing acetate of morphia, of which it is probable that three grains were given within three days. and two grains in little more than twenty-four hours. As the lady attended by Dr. Shearman was severely attacked with symptoms of tetanus from taking three doses of half a grain of acetate of morphia within seven hours it is quite possible that the same drug in the same dose, and in the aggregate of three grains in the space of seventy-two hours, may have proved fatal to a patient previously reduced by tartar emetic. The tetanic symptoms and death of Cook may therefore have been occasioned by acetate of morphia and not by strychnia, which Palmer bought, but, as he alleged, did not use (G.).

† 'Brain,' No. viii. Jan. 1880.

‡ Berl. Klin. Wochensch. No. 6, 1880.

medicine to a female in ill-health, was supposed to have proved fatal ('Lancet,' Nov. 1838), and it is probable that less than a grain in one dose would kill an adult. One grain injected under the skin in three doses of one-third of a grain each, within about twelve hours, appears to have proved fatal to a man under the care of Mr. de Morgan.

Treatment.—That of poisoning by opium and its preparations. The stomach-pump should be employed without delay. If not at hand, finely divided animal charcoal suspended in water might be administered with advantage, or solutions containing tannic acid, as strong green tea, or tincture of iodine largely diluted with water.

The treatment of chronic morphinism is not very hopeful. As a rule it is better to stop the drug at once and keep the patient under strict supervision; but occasionally dangerous depression ensues to such an extent as to require gradual diminution, or even readministration of the accustomed doses.

Experiments on Animals.—The effects of opium on man and the lower animals are not alike. Weir Mitchell has shown that pigeons are almost insusceptible of its influence. In frogs, and in some mammals, convulsions are present; and occasionally in man they are among the prominent symptoms. Much seems to depend on the equilibrium of function between the cerebral and spinal centres. Opium contains principles which act on both; and some of the anomalies in the train of symptoms are explicable on the supposition that in one person the spinal effect is most marked, in another, that on the supreme nerve centres.

The principles contained in opium were arranged by Bernard according to their narcotic or convulsive action, as follows:—*narcotic*, narcein, morphia, codeia; *convulsive*, thebaia, papaverin, narcotin, codeia, morphia. Their relative power is indicated by the order in which they are named. Codeia and morphia are classed both with the narcotics and convulsives.*

* Baxt places them in the following series, begining with the most convulsive, and ending with the most narcotic—viz., thebaia, narcotin, codeia, narcein, morphia, papaverin.

A derivative of morphia, formed by the action of hydrochloric acid on morphia at high temperatures, and termed by its discoverers (Mattheson and Wright) *apomorphia*, has a powerful emetic effect. Injected subcutaneously in doses of ·004-·01 grammes it causes repeated vomiting in a few minutes. Internally a somewhat larger dose is required. This drug may prove very valuable as an emetic in cases of poisoning.

CHAPTER X.

DELIRIANTS.

1. BELLADONNA.	4. SOLANUM NIGRUM.
2. HYOSCYAMUS.	5. SOLANUM DULCAMARA.
3. STRAMONIUM.	6. SOLANUM TUBEROSUM.

7. CAMPHOR. 8. COCCULUS INDICUS. 9. LOLIUM TEMULENTUM. 10. POISONOUS FUNGI.

THE poisons belonging to this group are characterized by the common property of causing delirium, with illusions of the senses; coupled with extreme dilatation of the pupil. Other poisons which affect the nerve centres either do not give rise to delirium, or they produce it only exceptionally; and if they dilate the pupil, it is less constantly, and in a less degree. Irritation of the stomach and bowels, and dysuria, or suppression of urine, are present in a certain number of cases. The first three poisons are the most important of their class; the others have less interest, and are more briefly noticed; the reader being referred for more ample details respecting them to treatises on toxicology.

I. BELLADONNA (*Atropa Belladonna, Deadly Nightshade*).

This plant is of the Linnæan class and order, *Pentandria Monogynia*, and natural order, *Atropaceæ*. It is indigenous, and grows in waste shady spots in some parts of England, flowering in June and July, and yielding ripe berries in September, Fig. 95 shows a cutting of the plant in flower, and a berry, whole and in section. The plant has a lurid hue, and when bruised gives out a faint fœtid odour. Cases of poisoning by the *root*, *leaves*, and *berries*, and by the medicinal *extract*, are on record, several of which proved fatal. A decoction of the root, given as a clyster, has also caused death; and serious symptoms have followed the external application of the extract to a blistered surface. The leaves and root are admitted into the British

Pharmacopœia. A tincture (one ounce to a pint, dose 5 to 20 minims) and an extract (one ounce to a pint) are obtained from the leaves; and a liniment (one ounce to a pint) from the root. The extract is used for making the ointment and plaster (80 grains to the ounce, and 50 per cent. respectively).

Fig. 95.

The plant owes its poisonous properties mainly to the alkaloid *atropia*, which has been admitted into the British Pharmacopœia, with one of its salts, the sulphate. The alkaloid supplies the liquor atropiæ (4 grains to the ounce), and an ointment (8 grains to the ounce): and the salt, the liquor atropiæ sulphatis (4 grains to the ounce).

The parts of the plant that have been taken as poisons are readily recognized. The *root* is thick and fleshy, branched and creeping; its section, white when fresh, is greyish when dried, and it has a slightly bitter taste. The *leaves*, often in pairs of unequal size, ovate and undivided, smooth and soft, are attached to the stem by short foot-stalks. The *berries*, of the size of a small cherry, with a deep central furrow, shining violet black colour, and sweetish taste, are enclosed in the enlarged calices, and have two cells, containing several seeds. They contain a liquid which stains white paper a rich durable purple.

The *seeds* of the small size, shown in 1, fig. 45, p. 394, with circular, oval, or kidney-shaped outline, and rounded surface, are nut-brown in colour, and weigh about ninety to the grain. By reflected light under a low power of the microscope, they have the appearance shown in the figure, and are studded closely with equal small round projections.

As the berries and seeds are very indigestible, portions of them will be found in cases of poisoning, in the matters rejected by the stomach, or passed from the bowels.

ATROPIA (*Atropine*).—The active principle of belladonna may be separated from organic mixtures by the Stas-Otto process described p. 395. When pure it consists of white silky crystals, which, when viewed under the microscope, are four-sided prisms. It belongs to the group of alkaloids not changed in colour when treated with cold sulphuric acid, nor when warmed. When heated it assumes a deep brown tint, and gives off an odour variously described as that of *orange-blossom* (Gulielmo), *prunus padus* (Dragendorff) or *spiræa ulmaria* (Pfeiffer, Otto). This odour, which is considered characteristic of the substance, is brought out more distinctly if to the sulphuric acid is added a little bichromate of potash or molybdate of ammonia, and sprinkled with a drop or two of water after heating.

It is not changed in colour by nitric acid. It is soluble in water, alcohol, ether, chloroform and benzole; also in dilute acids with which it forms crystalline salts. Its solution gives precipitates with the general reagents for alkaloids (p. 397).

It has no very characteristic chemical reactions by which it can be identified. The best test for atropia is the physiological test—viz., the dilatation of the pupil which it causes when dropped into the eye, in man or the lower animals, of which the cat is the best. According to Donders, one drop of a solution in the proportion of 1 to 130,000 produces the reaction.

Symptoms.—Dryness of the lips, mouth, and throat, with difficulty of swallowing, or even total inability to swallow; impaired utterance, or loss of voice; great thirst; the eyes prominent and sparkling; vision indistinct or lost, the pupils widely dilated, the face and upper part of the body flushed, the skin dry, and often covered with a scarlet rash, the pulse greatly accelerated and the breathing rapid. Nausea is sometimes present, with attempts at vomiting; and strangury with suppression or involuntary discharge of urine, which may contain blood; and excitement of the genitals. There is great agitation, and delirium is generally a very marked symptom. It is sometimes pleasing, accompanied by uncontrollable laughter or by incessant talking, sometimes only by voiceless motion of the lips, uniformly with spectral illusions. In some instances the state of the patient closely resembles somnambulism, in others intoxication, in others hydrophobia. The gait becomes staggering, and occasionally convulsions occur, usually clonic, rarely tonic. The individual falls into a state of coma which may alternate with delirium, or the coma may continue till death.

Invasion and Course.—The symptoms may set in within half an hour; but they rarely show themselves till two or three hours

after swallowing the poison. The fatal cases bear a small proportion to cases of recovery. Death, when it occurs, takes place within twenty-four hours. In one case it happened in fifteen, in another in twelve hours. In favourable cases the effects often last for several days; and some of the leading symptoms, such as impaired vision, and greatly dilated pupil, survive the patient's recovery.

Fatal Dose.—This seems to be very variable. Children are relatively less susceptible to the toxic action of belladonna. Serious symptoms have been produced even by one berry, and a case is reported of the death of a child nine months old from three of the berries. On the other hand recovery has taken place after eating as many as fifty berries. A teaspoonful of belladonna liniment proved fatal to a woman aged 66 in 16 hours (Beddoe, 'Lancet,' July 16, 1870). Less than one grain of atropia has produced serious symptoms, and two grains have proved fatal (Taylor). Severe toxic symptoms have also resulted from the external application of belladonna and atropia.

Post-mortem Appearances.—These are neither strongly marked nor characteristic. The cerebral vessels are congested, and there are red patches in the pharynx and œsophagus, and at the cardiac end of the stomach. The mucous membrane has been found of a dark purple colour throughout, or in patches, and portions of the berries and some of the seeds have been detected in the intestinal canal or in the stools.

The *diagnosis* is not free from difficulty; for similar symptoms are present in poisoning by hyoscyamus and stramonium. It is only when we discover some portion of the plant itself in the substances rejected from the stomach, or passed from the bowels; or, in a fatal event, in the contents of the alimentary canal, that we can state with confidence which poison has been taken. The description given of the part of the plant swallowed may, however, prove decisive. The berry is easy to recognise. It happens fortunately that the alkaloid atropia is eliminated from the kidneys, and can be detected by its action on the pupil. Dr. John Harley has repeatedly proved the presence of atropia in the urine by this means, within twenty minutes of the injection under the skin of $\frac{1}{48}$ or $\frac{1}{96}$ grain of the sulphate. Twelve drops out of eight ounces of urine secreted in $2\frac{1}{2}$ hours by a patient under the influence of $\frac{1}{48}$ grain will largely dilate the pupil, and maintain it in that state for several hours. One or two drops of urine are to be introduced between the eyelids every quarter of an hour till the effect is produced.

Treatment.—After the prompt use of emetics, animal charcoal

diffused through water, or diluted liquor potassæ or tannin, and after an interval, a full dose of castor oil. In other respects it will be determined by the symptoms actually present.

Though atropia appears to act as a physiological antagonist to morphia, the experiments of the Edin. Committee seem to show that morphia does not act conversely as an antagonist to atropia.

Atropia also antagonises to some extent the action of Calabar bean, but we have no data for determining whether the administration of Calabar bean would be serviceable in belladonna poisoning.

Experiments on Animals.—Belladonna acts powerfully as a poison on the carnivora; while many herbivorous animals, such as the ox, ass, and rabbit, can eat it with impunity. Its action on other mammals is similar to that on man; but it acts on the frog in a peculiar manner. According to the researches of Fraser the animal is first paralysed, and some hours after the administration of the poison appears quite dead, muscular irritability and slight action of the heart being the only signs of life. After a period of from 48 to 72 hours the fore-limbs are seized with tetanic spasms, which gradually develop into complete tetanus, closely resembling that caused by strychnia. The symptoms in man are in some respects explained by the effects observed on animals. The mode in which it acts on the brain to cause delirium is obscure. Fraser thinks the action on the spinal cord is first paralysing and then exciting. Belladonna paralyses the secretory nerves; hence the dryness of the mouth which is so characteristic an effect of the poison. It also paralyses the vagi, the inhibitory nerves of the heart; partly explaining the great rapidity of the pulse in belladonna poisoning. The interference with vision is due both to the dilatation of the pupil and paralysis of the muscles of accommodation.

II. HYOSCYAMUS (*Hyoscyamus niger, Henbane*).

This, too, is a plant of the Linnæan class and order *Pentandria Monogynia*, and natural order *Atropaceæ*. It is indigenous, and grows on poor waste lands, and on the sea-shore. Fig. 86 shows a cutting of the plant, a flower, and a seed-vessel. All parts of the plant are poisonous; and the seeds, root, leaves, and young shoots have been taken as poisons.

The leaves are in the British Pharmacopœia, and furnish two preparations—an *extract* and a *tincture*.

The several parts of the plant are easily recognised. The *seeds* are about the size and shape of those of Belladonna, but less rounded; about an eighteenth of an inch in diameter, and weighing 120 to the grain. They are thickly covered with ridges formed of nipple-like projections, marked with black lines, as shown in 2, fig. 45, p.394, which represents the seeds of their usual size, and as seen under a low power of the microscope, with a small section more magnified. The *root* is spindle-shaped, and bears some resemblance to a small parsnip, for which it has been eaten by mistake. It also somewhat resembles the wild chicory. The *leaves* sessile, and half embracing the stem, are of a pale dull green colour, slightly pubescent, with long hairs on the midrib, unequally cut at the sides and pointed at the end. The entire plant has a strong unpleasant odour, a mucilaginous and slightly acrid taste, and a clammy feel. The plant, and its officinal preparations, vary greatly in activity and strength, according to season of the year and mode of preparation.

Fig. 96.

Symptoms. — These are essentially those of poisoning with Belladonna. Hyoscyamus owes its activity to an alkaloid, *Hyoscyamine*, which may be extracted from organic matters by the Stas-Otto process. It is usually found as an amorphous or resinous substance, and is with difficulty obtained in the crystalline form. Its salts are non-crystallizable. It is soluble in water, ether, alcohol, fusel oil, benzole, and chloroform. Its solutions decompose in the air. They are precipitated by the general reagents for alkaloids (p. 397). Chloride of platinum in small quantity causes a precipitate which is soluble in excess. Hyoscyamine has no characteristic chemical reactions. As in the case of atropia, the

physiological test is the best. Like atropia it dilates the pupil, and it is said that the effect is more enduring. But apart from other evidence it would not be possible by this test to distinguish between hyoscyamine and atropia.

As the poison (either leaf or root) has generally been taken by mistake for some wholesome vegetable, and cooked as an article of diet, we are best acquainted with the symptoms as affecting several persons simultaneously. A poultice of the leaves applied to the abdomen, and a decoction used as a clyster, have produced poisonous effects.

Post-mortem Appearances.—Not characteristic. Congestion of the brain and lungs has been observed.

Treatment.—That of poisoning by belladonna.

Experiments on Animals.—On some animals, such as the sheep, the cow, and the pig, hyoscyamus seems to have little or no effect. The action of the poison has been studied by Oulmont and Lamart and Boehm on frogs, rabbits, guinea pigs, cats and dogs. The effects are similar to those on man, especially in the paresis or paralysis of the lower extremities. In other respects the action is similar to that of belladonna.

III. STRAMONIUM (*Datura Stramonium, Thorn-Apple*).

This also is a plant of the Linnæan class and order *Pentandria Monogynia*, and natural order *Atropaceæ;* growing in waste places and on dung-heaps in all parts of Europe. The annexed figure (fig. 97) shows a cutting of the plant with sections of the flower and fruit. The entire plant has a rank odour; but the flowers are sweet-scented. The *leaves* are of a dull green colour, large, sharply and irregularly cut at the edges, smooth, ribbed, and veined. Every part of the plant is poisonous; but the fruit and seeds are believed to be the most active. The vapour of the flowers is asserted to have produced poisonous effects. In France and Germany, as also in India, and the Eastern Archipelago, the seeds of this or of other species are given to aid the commission of crime. Cases of poisoning by the leaves, fruit, seeds, and extract are on record; and dangerous symptoms have been occasioned by their external application. It is smoked with or without tobacco as a remedy for asthma.

Stramonium owes its poisonous properties to an alkaloid known as *daturia*, which however, has been shown by v. Planta to be identical with *atropia*.

The leaves and seeds are in the British Pharmacopœia, and the seeds supply an extract and a tincture.

Fig. 97.

The *fruit*, or apple, the size of a walnut, has a strong prickly outer coat. The *seeds* are light brown or black, circular or kidney-shaped, flattened, with a corrugated surface. They are much larger than those of henbane or belladonna; for while the seeds of henbane weigh 120, and those of belladonna 90 to the grain, there are only about eight stramonium seeds in one grain. The size, and the microscopical appearance of the cuticle of the seeds, are shown in fig. 98.

Experiments on Animals.—The effects produced by stramonium are those of belladonna and hyoscyamus. In common with them, it largely dilates the pupil.

Symptoms. — These nearly resemble those of poisoning by henbane and deadly night-shade; but they begin sooner, and are more severe. Delirium may be present in fifteen minutes, and death take place in seven hours. There are dryness of the throat, flushing of the face, dilated pupils, delirium, with spectral illusions, accompanied by convulsions and followed by coma, and, in some instances, irritation of the alimentary canal.

Fig. 98.

Post-mortem Appearances.—In some cases congestion of the vessels of the brain, and in one instance redness of the cardiac end of the stomach.

The *diagnosis* of poisoning by stramonium is effected by the discovery of portions of the plant in the alimentary canal, or in the matters vomited or discharged from the bowels.

Treatment.—As in poisoning by belladonna and hyoscyamus.

IV. SOLANUM NIGRUM (*Black, or Garden Nightshade*).

This is an annual, common in gardens, by roadsides, and near manure-heaps, growing to a height of one or two feet, and

bearing small white flowers, and berries which, when ripe, are black. Fig. 99 shows a cutting, with flowers and berries. The berries and leaves have been eaten by children, and have given rise to characteristic symptoms.

Symptoms.—These combine intestinal irritation (nausea, vomiting, colic pains and intense thirst), and cerebral symptoms (delirium, restlessness, convulsions, tetanic spasms, and extreme dilatation of the pupil). They are well described in two cases cited by Tardieu from M. Magne, who ascertained beyond doubt that they were due to the leaves of the solanum nigrum.

At some time between 5 and 7 P.M., two children, $3\frac{1}{2}$ years of age, ate the leaves, and about eight o'clock began to show symptoms of poisoning. One child died, the other recovered. In the child who died there was pain in the belly, gradually increasing, and attended by nausea without vomiting, then restlessness followed by delirium. These symptoms increased till towards midnight, when the child was so restless and delirious as to be with difficulty kept in bed. When seen by M. Magne, he found the belly greatly distended, the pulse very quick and scarcely perceptible, the respiration hurried, the face pale, and the pupils enormously dilated. The limbs were convulsed, the child became insensible, and sank about twelve hours after taking the poison. The child who recovered passed the whole night restless, and sleepless, frightened, and troubled with illusions. When seen by M. Magne she was asleep, with natural pulse and respiration; but on the second visit was awake and sitting up in bed, her face expressive of astonishment and fright, her pupils dilated to the utmost, and fixed; but she soon began to recognise her parents, fell into a deep but disturbed sleep, and recovered in about twenty-four hours, though the pupils still continued dilated.

Fig. 99.

V. SOLANUM DULCAMARA (*Woody Nightshade* or *Bitter-sweet*).

This is one of the most common plants of our hedges and road-sides, growing to many feet in length, and twisting among the branches of trees. It begins to flower in June, and continues to produce flowers and berries till late in autumn. Its purple petals with rich yellow stamens, and bright red berries, make this plant one of the ornaments of our hedgerows (fig. 100).

The red berries of this plant do not appear to possess the active properties of the black berries of the solanum nigrum, though they prove more attractive to children. They proved fatal to a boy, four years of age, while two older sisters, who ate them at the same time, suffered slightly or not at all. The symptoms in this fatal case were vomiting and purging, convulsions, and in-sensibility alternating with each other, and death in convulsions.* The evidence as to the poisonous properties of the berries of this plant, and their degree of activity, is very conflicting, and the case just cited is not free from the suspicion that some of the black berries of the solanum nigrum were eaten at the same time. Bourneville ('Gaz. des Hôp.' 1854), has recorded a case of severe symptoms in a child aged 11, from ten dulcamara berries.

Fig. 100.

VI. SOLANUM TUBEROSUM (*the Potato*).

The berries and young shoots of this plant possess poisonous properties, and the berries have proved fatal. In the case of a young lady æt. 14, reported by Mr. Morris of Merford,† there were great restlessness, anxiety, and jactitation; the skin was livid and covered with a cold, clammy perspiration, the respiration hurried, the pulse very quick and weak, the jaws contracted, the speech lost, the tongue covered with a dark brown moist fur; and the patient constantly spat a viscid froth through the closed teeth. She died on the second day.

SOLANIA (*Solanine*).—The three plants above mentioned, as well as some others belonging to the same order, owe their activity to *solanine*, which appears to have the properties both of a glucoside and alkaloid. It occurs as a white powder, but may be

* 'Lancet,' June 28, 1856, p. 715.
† 'British Medical Journal,' 1859, p. 719.

extracted in the form of delicate acicular crystals. It has a bitter taste, followed by an acrid sensation in the throat. It is feebly alkaline. With cold sulphuric acid it assumes a bright yellow tint, changing to brown when warmed, and becoming darker on heating. By this treatment, as well as by hydrochloric acid, it is split up into sugar and an alkaloid *solanidine*. Solanine is dissolved in nitric acid without change of colour at first, though it changes ultimately to red. When heated on porcelain, it discolours, melts slowly, gives off a dense vapour which has the odour of baked apples, and swells into an abundant carbon. It sublimes at 420° Fahr., and deposits on the glass disc the characteristic long needles, variously crossed and interlaced, shown in the annexed figure. It is sparingly soluble in water, but soluble in acids, with which it forms salts, soluble in alcohol and amylic alcohol, but insoluble or nearly so in ether, benzole and chloroform. Its solutions have a tendency to gelatinize. Owing to its insolubility in ether, whether in acid or alkaline solutions, it resembles morphia, and is extracted like morphia, in the Stas-Otto process by amylic alcohol. Besides differing in its other reactions from morphia, it is distinguished by the fact that if treated with concentrated hydrochloric acid it gives solanidine, which is readily soluble in ether, while the hydrochlorate of morphia is insoluble. Its liquid reactions are mostly of a negative character; it yields no precipitate with most of the reagents that give abundant and often characteristic crystals with several other alkaloids. From its alcoholic solution, and as sulphate, it is deposited as delicate needles, crossed and interlaced, or radiating from a point.*

Fig. 101.

Experiments on Animals.—The action of solanine is a subject on which experimenters are not quite agreed. According to the researches of Clarus and others, large doses (0·5 grammes) cause vomiting, a quickened, followed by a slow respiration, and paresis of the lower extremities. Death occurs with excessively weak and rapid pulse, and occasionally with convulsions. Solanine is said not to affect pigs. Experiments on man have shown that it has a similar effect on the circulation and respiration, and causes dry skin, nausea, and great prostration. Applied locally, is does not cause dilatation of the pupil; but solanidine, its derivative, has this action.

* Wormley, Pl. xiii. figs. 5 and 6.

VII. CAMPHOR.

This substance is decidedly poisonous, but has only proved fatal in a few instances.

Properties.—It is a colourless, translucent, and semi-crystalline substance, of a tough texture, strong and peculiar odour, and pungent, yet cool taste. It floats on water, in which it is sparingly soluble, evaporates at common temperatures, and is deposited on cool surfaces (as on the inside of bottles) in crystals. It is readily dissolved by alcohol, ether, chloroform, and the volatile and fixed oils. It imparts its peculiar odour to the breath.

When taken as a poison it is usually in fragments, and being sparingly soluble in the contents of the stomach, would be easily identified. If dissolved in spirit, it may be separated by distillation, and thrown down by the addition of water.

Symptoms.—These begin with languor, giddiness, dimness of vision, and confusion of intellect, followed by depression, intoxication, or violent delirium. Convulsions also occur, especially in children; and there is much excitement of the circulation, with heat of skin, flushed face, hurried pulse, and dilated pupil. Recovery takes place after a long, deep sleep.

In a case given by Klingelhöffer (abstract in 'Lond. Med. Rec.,' vol. i. p. 654), a woman took 30 grains of camphor, and immediately complained of giddiness, which rapidly increased, followed by headache, burning pain in the stomach, eructations, and great thirst, and formication in the extremities. Six hours after she had pallor and coldness of the face and extremities, and small irregular pulse. The giddiness and tremor had passed away, but there was constant movement of the hands. Next day, under treatment, she recovered.

Mr. J. C. Bellamy, of Plymouth, communicated to me the following account of the effect on himself of twenty grains of camphor dissolved in spirit. Giddiness came on almost immediately, he fell into a chair, had a series of fits of uncontrollable laughter, followed by extreme faintness and cramps. Then ensued nearly complete paralysis, the voice being reduced to the faintest whisper. This state continued several hours, and left behind it great debility. The mind was not affected (G.).

Dr. G. Johnson * has recorded several cases in which dangerous symptoms, convulsions, coma, long continued nervous prostration, &c., have resulted from taking a highly concentrated homœopathic solution of camphor (nearly equal weights of camphor and alcohol) in what would be ordinary medicinal doses of the spirit of camphor of the Brit. Pharmacopœia (1 in 10).

* 'Lancet,' Nov. 22, 1873.

Post-mortem Appearances.—These, as observed in animals, are inflammation of the stomach and bowels, injection of the membranes of the brain, and inflammation of the urinary passages. The odour of the poison pervades the whole body.

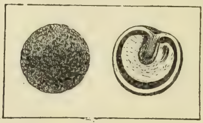
Smallest Fatal Dose.—Twenty grains have produced serious symptoms in an adult male, and thirty grains have killed an infant eighteen months old, in seven hours.

Treatment.—This consists in the prompt use of emetics, followed by castor oil as a purgative. The discharge of the contents of the stomach is generally followed by speedy relief.

VIII. COCCULUS INDICUS (*Levant Nut*).

This is the berry of a plant known as the Menispermum, or Anamirta Cocculus, which has the size, shape, and section shown in Fig. 102. An extract of the berries is sold for poisoning fish, the flesh of which, when used in large quantity, it renders poisonous; and a decoction or extract is used by thieves to give an intoxicating quality to ale, porter, and spirits. In two instances, at least, the poison has proved fatal in the human subject. The shell acts as an emetic, while the seed contains 1 to 2 per cent of an active poison (Picrotoxine).

Fig 102.



Picrotoxine.—This consists of colourless prismatic crystals, which have an intensely bitter taste. It is not an alkaloid. It belongs to the group of active principles which does not change colour with cold sulphuric acid; but becomes yellowish when warmed, and brown when heated. When heated on porcelain it melts, darkens, effervesces, gives off vapour, forms large bubbles which break, and leaves a moderately abundant carbon. It sublimes at 320° Fahr., but the sublimate is not characteristic. Nitric acid dissolves it without change of colour. If mixed with twice or thrice its bulk of nitre and moistened with sulphuric acid no change is produced, but when rendered distinctly alkaline by caustic potash, a reddish-yellow colour appears (Langley). An alkaline solution, with addition of sulphate of copper, when heated, deposits the oxide of copper. It is soluble in 150 parts of cold water, and readily dissolves in alcohol, ether, chloroform, and fusel oil. It is also sparingly soluble in acids, but soluble in solutions of potash and soda, towards which it acts like an acid. Solutions of picrotoxine are not precipitated by iodine, tannin, or the chlorides of gold, platinum, or mercury. From organic liquids

such as beer and porter, picrotoxine may be readily obtained by acidulating with hydrochloric acid, then shaking the liquid with ether, which dissolves the poison, and deposits it as crystals. Langley ('Pharm. Journal,' 1862, p. 277).

From organic liquids it is obtained by the Stas-Otto process in common with colchicin and digitalin by extraction of the acid solution with ether (see p. 397). It is distinguished from these two in solution by not being precipitated by tannin.

Symptoms.—We know little of the effects of cocculus indicus and picrotoxine on man. It is said to cause gastro-intestinal irritation and a heavy lethargic stupor and powerlessness. Its action on animals has been more studied. Crichton Browne ('Brit. Med. Journ.,' March 27, et seq. 1875) finds that a twentieth of a grain of picrotoxine kills rabbits with peculiar opisthotonic epileptiform convulsions. Fishes make strange sinuous movements and fall on the side powerless. Frogs, according to Röber, are affected with tonic and clonic convusions, and a peculiar inflated condition of the abdomen, due to a sort of inspiratory tetanus. This is considered a physiological test of picrotoxine.

Fig. 103.

Treatment. — Crichton Browne has shown that the effects of picrotoxine in rabbits are completely counteracted by the subcutaneous injection of chloral hydrate (10 to 12 grains.)

IX. LOLIUM TEMULENTUM (*Darnel*).

The seeds of this plant are sometimes mixed with other grains used for distillation, or ground into flour for making bread. When so used, they may produce marked symptoms of poisoning, including heat of throat, headache, giddiness, staggering as if from intoxication, strong tremulous

movements of the limbs, impaired vision, symptoms of collapse, and vomiting. The annexed engraving shows a cutting of the plant, with an enlarged flower (*c*) and vertical section of the seed (*e*).

X. POISONOUS FUNGI.

The fungi constitute a large class of plants, of which some are eaten with impunity, except by a few persons of peculiar constitution; and many more, habitually eaten on the Continent, are now recommended for use in England; while others at least as numerous are esteemed, or known to be, poisonous.

The *symptoms* of poisoning by fungi are very variable in the time at which they appear; sometimes coming on soon after eating them, in other cases, after an interval of some hours, and even as late as twenty-four, or even thirty-six hours. Nor are the symptoms always developed in the same order, for symptoms of irritation of the alimentary canal sometimes precede the nervous symptoms, sometimes follow them; and in the same group of cases, some suffer from intestinal irritation, others from nervous symptoms. The symptoms of irritation consist of constriction of the throat, nausea, heat and pain of stomach, painful retchings, and vomiting with or without purging; and the nervous symptoms of headache, giddiness, dimness of sight, illusions of the senses, delirium and coma. The symptoms caused by most of the poisonous fungi often run a rapid course, without intermission or relief, and death may take place within twenty-four hours. One poisonous fungus (Amanita muscaria) appears to produce a pleasing intoxication, followed by stupor, and is in use among the natives of Kamschatka. The urine contains the active principle, and when drunk by others causes the like feeling of intoxication. From this fungus Schmiedeberg has isolated an alkaloid called *muscarin*, which is soluble in water and alcohol, and sparingly in chloroform, but not at all in ether. This alkaloid, when given to cats in poisonous doses (0·002 to 0·004 grammes), causes increased flow of tears and saliva, expulsion of excreta, contraction of the pupils, a slow pulse, dyspnœa, and death with slight convulsions. It exerts a special action on the heart, causing it to stop in the state of diastole. This effect is attributed to irritation of the inhibitory apparatus of the heart itself. The effects of muscarin are completely antagonised by atropia.

Post-mortem Appearances.—These are not characteristic. Indications of irritation of the intestinal tract, and a condition of the viscera as in asphyxia have been found.

The *Treatment* consists in the prompt use of emetics of common salt, followed by a full dose of castor oil, and the free exhibition of mucilaginous drinks. Lauder Brunton recommends the subcutaneous injection of atropia as a physiological antidote.

Diagnosis.—The distinction of poisonous and esculent fungi is less easy than might be wished. With the exception of the common field mushroom (*Agaricus campestris*) and of the puff-ball (*Lycoperdon giganteum*) in its early growth, while presenting a compact white texture throughout, there are few, if any, edible fungi which the common people can be trusted to distinguish from poisonous ones. Even when the two kinds are contrasted in charts faithfully drawn and coloured, some care is needed to distinguish one or two of the species from others which resemble them. Nor can the general rules that have been laid down for the distinction of the one class from the other be depended on. The vulgar test of the silver spoon which is supposed to be discoloured when boiled with poisonous fungi, is quite useless; though it may serve to indicate decomposition, and the formation of sulphuretted hydrogen. The following general precautions may, however, be observed with advantage:—Rejecting, to begin with, all fungi that have an eminently offensive and repulsive odour, and those which present green or scarlet colours of unusual brilliancy; those also, should be disallowed which have a bitter, styptic taste, burning and parching the throat; those, too, that have a livid hue, and assume various colours when broken or bruised; those again which rapidly deliquesce, or yield a "spiced milk" of whatever hue, and whether changing colour or not. These rules should be observed by the ignorant, and not be broken without caution by the better informed.* In the cooking of fungi the free use of salt and vinegar is recommended. Some volatile poisonous matters are also dispelled at the boiling temperature. It may be well to add that wholesome fungi have been rejected through prejudice; or in consequence of the occasional production of symptoms of indigestion by stale fungi, or by those which unite a compact texture with the presence of nitrogen. The common mushroom, so largely eaten in England, is rejected in Italy.

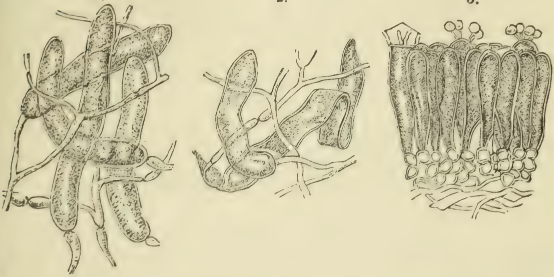
The peculiar microscopic texture of the cellular tissue, and spores of the fungi, whether wholesome or poisonous, may enable

* Reference may be made to the scientific and learned treatises of Berkeley and Badham ('Outlines of British Fungology,' and the 'Esculent Fungi of England'), to the more popular work of M. C. Cook, and the coloured charts, with explanations, by W. G. Smith.

us to ascertain by an examination of the contents of the stomach, or vomited matters, that some fungus has been taken with the food.

Fig. 104.

1. 2. 3.



The annexed illustrations, after larger drawings given by Tardieu, on the authority of M. E. Bondier, show these characteristic structures. Fig. 94, 1, shows the cellular tissue of the *pileus* of the Amanita bulbosa; 2, shows the same tissue after cooking; 3, the *hymenium* and sub-hymenial tissue of the same, with the *bassidia* surrounded by four *stigmata* bearing spores.

Fig. 105.

1. 2. 3. 4.

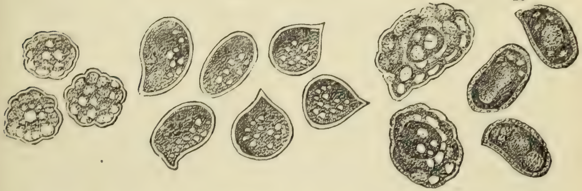


Fig. 95, 1, shows the spores of the Russula emetica; 2, those of the Amanita bulbosa; 3, those of the Lactarius deliciosus; 4, and the ripe spores of the Agaricus campestris, or common mushroom.

CHAPTER XI.

INEBRIANTS.

I. ALCOHOL. II. ETHER. III. CHLOROFORM. IV. CHLORAL.

CARBOLIC ACID, BENZOLE, NITRO-BENZOLE, ANILINE, COAL NAPHTHA, WOOD NAPHTHA, OIL OF TURPENTINE, KREASOTE, AMYLENE, AND AMYLIC ALCOHOL. NITRO-GLYCERINE. DIPPEL'S OIL.

THE poisons alcohol, ether, and chloroform, have the common property of inducing a state of narcotism, often preceded by delirious excitement, and followed by indisposition, of which nausea and vomiting are generally the leading symptoms. In large doses, and in a concentrated form, they may destroy life suddenly by shock ; but they generally prove fatal by coma, or by paralysis of the heart. They act as irritants to the parts with which they come in contact, producing intense inflammation in the lining membrane of the stomach when swallowed, and in that of the air-passages when inhaled. But they do not affect the whole tract of the intestinal canal, as poisons of the irritant class do.

All the poisons of this group are more or less volatile, and their vapours, when inhaled, act more powerfully than like quantities of the liquids themselves when swallowed. A special importance attaches to ether and chloroform as anæsthetics.

I. ALCOHOL.

Alcohol, or spirit of wine, is the active ingredient of a great variety of intoxicating agents obtained from fermenting saccharine juices. By the distillation of such fluids, followed by rectification with charcoal, and a final distillation with quick-lime, *anhydrous* or *absolute* alcohol is obtained. This, diluted with 16 per cent. of water, constitutes rectified spirit, and with little more than its weight of water, *proof spirit*, which differs little in strength from the various *ardent* spirits distilled from wine, malt, molasses, or rice, flavoured and coloured with burnt sugar, juniper berries, and peat, and known as brandy, hollands or gin, whisky, rum, arrack. The absolute alcohol in these ardent spirits varies from

51 to 54 per cent. Of the stronger wines it constitutes from 12 to 17, of the lighter wines from 7 to 9, and of the stronger English malt liquors from 5 to 6 per cent.

Properties.—Pure alcohol is a colourless, volatile liquid of low specific gravity (0·795), boiling at 173°, and not freezing at the lowest attainable temperature. It has a pleasant odour and pungent taste, is very inflammable, burns with a light-blue flame, and yields, as products of combustion, carbonic acid and water.

Tests.—*a.* When burned, it leaves no stain of charcoal. *b.* The products of combustion render lime-water or the solution of nitrate of baryta white and turbid. *c.* It dissolves camphor. *d.* To a drop of alcohol add dilute sulphuric acid, add a drop of a solution of bichromate of potash, and apply the heat of a spirit-lamp. The orange-coloured solution is changed to green by the liberation of oxide of chromium, and the fruity odour of *aldehyd* is perceived at the mouth of the tube. *e.* On gently heating a liquid containing alcohol, to which a few particles of iodine and enough caustic potash to make a nearly colourless solution has been added, a yellow precipitate of *iodoform* is thrown down, consisting of hexagonal tables, when examined with the microscope. *f.* Heated with sulphuric acid, and an acetate, the characteristic odour of *acetic ether* is developed.

In Organic Liquids.—The contents of the stomach in persons killed by large doses of spirituous liquors generally have the odour of the spirit. If they contain any spirit it may be separated by distillation. If they have an acid reaction, they must first be neutralized by potash. The liquid resulting from the distillation may be identified by the tests just enumerated applied as follows:—Dip a glass rod into the distilled liquid, and see if it burns. Apply the tests as above. If these tests fail, place the liquid in a tube, and add dry carbonate of potash as long as it dissolves. The water will be taken up by the carbonate of potash, and the alcohol will rise to the surface. Draw this off with the pipette, and repeat the tests.

Alcohol is absorbed, and may be detected by its odour, and by tests applied to the products of distillation in the blood and secretions, in the brain, and in other solid viscera.

Experiments on Animals.—From Sir Benjamin Brodie's experiments on rabbits with large quantities of proof spirit, it appears that symptoms of poisoning set in immediately or in a few minutes, and that death ensues in from half an hour to an hour and a quarter. In one experiment two ounces of proof spirit were injected into the stomach of a rabbit, and the injection was scarcely completed when the animal became perfectly insen-

sible. It appeared dead in twenty-seven minutes, but the heart had not ceased to beat. The symptoms were complete insensibility, dilatation of the pupils, rapid pulse, laborious and stertorous breathing, and slight convulsions. The lining membrane of the stomach bore marks of acute inflammation.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—After a period varying from a few minutes to an hour or more, according to the quantity and strength of the alcoholic liquid—a period during which there is often an agreeable physical and intellectual excitement—the symptoms set in with confusion of thought, headache, giddiness, imperfect or double vision, indistinct and stammering speech, uncertain and abrupt movements of the limbs, and a tottering and stumbling gait. At length the patient becomes speechless, motionless, and insensible, with a bloated and suffused countenance, injected eye, dilated and fixed pupil, livid lip, and slow stertorous breathing. Recovery may take place after a prolonged sleep attended with profuse perspiration, or more abruptly by vomiting; or death may occur after an interval of several hours with symptoms of collapse, indicated by pallor of the face, cold sweats, quick and feeble pulse, involuntary evacuations, and complete relaxation of the limbs. Very large quantities of ardent spirits kill almost instantaneously by shock. Insensibility either sets in suddenly, or as a relapse after apparent recovery. Convulsions are among the occasional symptoms, and delirium tremens and raging incoherence are sometimes the result of a single debauch.

Diagnosis.—Alcoholic poisoning may simulate concussion of the brain, apoplexy, or poisoning by opium. When a patient is seen in the advanced stages of alcoholic coma, an absolute diagnosis is extremely difficult, and, in some cases, impossible. The smell of drink only indicates that the person has been drinking, not that the symptoms are caused by alcohol; for the patient may have been only drinking moderately, and yet be suffering from cerebral hæmorrhage or narcotic poisoning. The smell of drink would, however, indicate the necessity of resorting to the stomach-pump. Hughlings Jackson relates the case of a person supposed to be intoxicated, who was left to sleep it off, but who was really suffering from the effects of cerebral hæmorrhage. The appearance of the face and the state of the pupils are subject to so much variation, that no absolute reliance can be placed on them. The face in alcoholic coma is sometimes flushed, sometimes pale, and the pupils though usually dilated may be contracted. As a rule the pupils are dilated in alcohol poisoning,

contracted in opium poisoning, and unequal in cerebral hæmorrhage; but exceptional cases occur and render the diagnosis difficult. Caution is therefore requisite in all cases of coma, and where no history is obtainable, or clear indications from the contents of the stomach, the examination of the urine, &c., a positive diagnosis should be reserved and the patient carefully watched.

Post-mortem Appearances.—The most constant appearance is a deep crimson or dusky red colour of the lining membrane of the stomach, sometimes extending upwards to the gullet and downwards to the commencement of the small intestines. In some cases there is dark extravasation under the lining membrane; in others, there are inflamed patches; in others, again, no marks of inflammation in any part of the organ. Congestion of the brain and of the air-passages are less constant appearances. The alcoholic odour is perceptible in the brain.

Treatment.—The stomach-pump should be used without delay, and the cold affusion as a shock. The after-treatment will depend on the patient's state. If there is great difficulty of breathing, with cold surface and feeble pulse, the treatment proper to asphyxia may be required.

Chronic Poisoning by Alcohol.—Drunkards suffer from functional and organic diseases of all the important organs of the economy: from indigestion, with vomiting and purging, through irritation of the stomach and bowels; from jaundice, through irritation of the liver; from albuminous urine, diabetes, and other urinary disorders, through irritation of the kidney; from congestion of the brain, delirium tremens, and insanity, paralysis, convulsions, and shaking palsy, as the effect of the poison on the nervous centres. The organic diseases induced by the prolonged abuse of spirituous liquors are degeneration of the liver, kidneys, heart, brain, and spinal cord, scirrhus of the stomach, and pulmonary consumption. Dropsy is a common result of the organic diseases of the drunkard.

II. ETHER.

Several volatile and inflammable liquids are known under the general name of *ether*, and they are divided into the three groups of simple, double, and compound ethers. The liquid known as ether, ordinary, vinic, or sulphuric ether, belongs to the first group, and is the poison here spoken of. It is the product of the distillation of a mixture of alcohol and sulphuric acid.

Properties.—Pure ether is a limpid, colourless liquid, highly volatile and inflammable, with a specific gravity of 0·735°, boiling at 95°, and freezing at about —24°. It evaporates without

residue, burns with a yellow flame, and deposits charcoal on cooled surfaces, but when burned with a proper proportion of oxygen is resolved (like alcohol) into carbonic acid and water. It yields a dense, inflammable vapour, which forms with oxygen or air, in certain proportions, an explosive mixture. Its odour is penetrating and characteristic, and its taste hot and pungent, but in evaporating it gives a sensation of cold. It is sparingly soluble in water, but freely in alcohol. It is also a powerful solvent of several bodies, among others iodine, corrosive sublimate, and certain of the alkaloids.

Tests.—*a.* Its characteristic odour. *b.* Its imperfect combustion, leaving a stain of carbon on cool surfaces. *c.* Its partial solubility in water, the bulk of the liquid floating on the surface. *d.* It has the same reaction as alcohol with bichromate of potash and sulphuric acid.

In Organic Liquids.—Ether is separable from the contents of the stomach, &c., by the same process of distillation as alcohol.

Symptoms, &c.—The effects of ether are essentially the same as those of chloroform.

III. CHLOROFORM.

Chloroform, or chloroformyl, is one of the large class of chemical compounds formed by substituting chlorine, bromine, or iodine for the hydrogen of the simple or compound ethers. It is obtained by distillation from a mixture of slaked and chlorinated lime, rectified spirit, and water.

Properties.—Chloroform is a colourless liquid, of high refractive power and high specific gravity (1·497), very volatile, giving off a dense vapour, and boiling at 142° F. It has a sweet pungent taste, and a strong pleasant odour compared to that of apples. It is perfectly soluble in alcohol and ether, but very sparingly so in water, in which it sinks in large globules. If pure it has a neutral reaction, does not discolour oil of vitriol, has no odour of chlorine, and leaves no unpleasant odour on evaporation. It dissolves camphor, volatile oils, wax, resin, caoutchouc, gutta percha, iodine, bromine, sulphur, and phosphorus, and some of the alkaloids, among which strychnia is the most important. At a red heat its vapour is resolved into chlorine and hydrochloric acid.

Tests.—*a.* Its taste and odour. *b.* Its high specific gravity and sparing solubility in water. *c.* It is not easily inflamed, and burns with a green flame. *d.* It completely dissolves camphor, gutta percha, and caoutchouc. *e.* It produces its characteristic effects on small animals.

In Organic Mixtures.—Liquid chloroform may be separated

from the contents of the stomach by distillation at 120° F. The vapour may be detected in the blood and tissues by the same process, or by one based on the fact that, when transmitted through a tube heated to redness, it is decomposed and resolved into chlorine, hydrochloric acid and carbon. The method of procedure is very simple. The organic matter is put into a flask with a narrow tube bent at right angles. On heating the mixture to a temperature of about 150°, the chloroform is volatilized, and on heating the tube with the flame of a spirit-lamp, is decomposed. The vapours that issue from the open end of the tube, if received on paper moistened with solution of iodide of potassium and starch, develop the characteristic blue colour; if received on a glass plate, moistened with a solution of nitrate of silver, the chloride of silver is formed; while moistened litmus paper is first reddened and then bleached. As chloroform, however, seems to form some chemical compound with the blood, it is not readily obtained from it by distillation.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Applied locally chloroform acts as an irritant to the skin and mucous membranes. When swallowed it causes symptoms of irritant poisoning rapidly followed by coma. When inhaled it causes a sense of choking and stupefaction followed by delirious excitement, characterized by shouting, laughing, singing, and violent struggling. The circulation and respiration are quickened, the face flushed and the pupils contracted. Consciousness is not entirely obliterated at this stage, but sensory impressions are distorted or misinterpreted. The stage of excitement is followed by a calm. Struggling ceases, the muscles become flaccid, sensation is abolished, and the conjunctiva may be touched without producing reflex action. The breathing is quiet, the pulse regular, the face pale and the pupil contracted. This condition of insensibility may be maintained with care for an indefinite period, during which all operations may be performed without pain. If, however, the vapour is administered continuously, the breathing becomes stertorous, and the pulse weaker, the pupil dilates, and asphyxia is imminent. Not unfrequently both pulse and respiration stop suddenly without previous indications of danger, and all attempts at resuscitation, such as suffice for mere asphyxia, prove unavailing. This suddenly fatal termination may occur at any stage of the inhalation, and before an operation has been commenced.

Mode of Action.—The mode of action and cause of death from chloroform and ether inhalation have been much investigated, but

the explanations offered are to a large extent speculative. It has been supposed by some that the characteristic effects are due to the action of chloroform on the blood, but it is more probable that it acts directly on the nerve centres. Death appears to result from paralysis of the respiration or circulation. In those cases where death is gradual after too prolonged administration the phenomena are those of asphyxia. When death is sudden the heart seems to be primarily affected. The danger of paralysis of the heart is greater the more concentrated the vapour. From comparative experiments with ether and chloroform it would appear that ether has less tendency to paralyse the heart, and therefore ether has been of late preferred by many to chloroform as an anæsthetic. Deaths from chloroform have in many instances occurred from slight but painful operations, such as extraction of a tooth, or toe-nail. In such cases death has been attributed to reflex stoppage of the heart, from irritation of the sensory nerves when the operation is commenced before reflex excitability is abolished or sufficiently reduced (Brunton ; Richardson).

Post-mortem Appearances.—In many cases the appearances are those of asphyxia. The odour of chloroform is perceptible on opening the body. It is especially observable in the cerebral ventricles. The heart is frequently collapsed and flabby. In cases of sudden death the heart may be found in a state of fatty degeneration. Sometimes bubbles of gas are observed in the blood. Their exact nature is not determined. The post-mortem appearances are, therefore, neither very definite nor characteristic.

Fatal Dose.—A drachm of liquid chloroform swallowed by a boy of four years old, proved fatal in three hours.*

Ether and Chloroform.—Ether may be taken internally in much larger doses than chloroform without danger. There are no fatal cases on record from internal administration. As regards inhalation, the fatality does not depend so much on the quantity as on the mode of administration, and on susceptibilities not always capable of being ascertained beforehand. It is particularly dangerous in fatty degeneration of the heart. The dangers of administration are giving the vapour not sufficiently diluted with air (4 or 5 per cent. of chloroform suffices), and pushing it beyond the stage of anæsthesia into that of asphyxia.

A relatively large quantity of ether vapour is required to produce anæsthesia, and the effects are more transient.

Treatment.—Cold affusion as a shock, followed by the treatment proper to asphyxia (p. 284). Bleeding from the jugular may sometimes be of benefit. Attempts to excite respiration and

* Taylor 'On Poisons,' p. 740.

circulation by galvanism or Faradization have been made, but apparently with little success. In poisoning by liquid chloroform, the treatment should commence with the use of the stomach-pump.

IV. HYDRATE OF CHLORAL.

Hydrate of chloral, introduced by Liebreich in 1869, as a hypnotic and anæsthetic, has come into extensive use in medicine, and numerous cases of accidental and suicidal poisoning by it have been reported.

Properties.—Chloral, produced by the action of chlorine on alcohol, forms with water the hydrate of chloral, which is a white crystalline substance, possessing a penetrating odour and a hot burning taste. It is freely soluble in water, alcohol, and ether. It may be extracted from watery solutions by ether and obtained in crystals on evaporation. Under the influence of alkalies it is decomposed into chloroform and formic acid. From organic liquids containing chloral, chloroform may be obtained by distillation, when they have been made strongly alkaline with caustic potash.

Symptoms.—After chloral has been given in a medicinal dose, in a few minutes a heaviness comes on passing into deep natural sleep. Sometimes, however, it gives rise to great excitement and delirium. In poisonous doses it causes a more profound sleep, passing into coma. The respirations become few in number and the pulse becomes weak, rapid, and irregular. There is complete muscular prostration and anæsthesia. The temperature falls, and the extremities become cold. The pupils are at first contracted, then dilated. Death takes place in coma, from cessation of the respiration, or circulation ; and in some cases a short time after taking the drug, from sudden stoppage of the heart.

Experiments on Animals.—Hydrate of chloral produces in animals effects similar to those in man. In toxic doses it causes profound coma and anæsthesia, and kills by causing paralysis of the circulation and respiration. It lowers the temperature in a remarkable degree. The action of chloral has been attributed to the liberation of choloroform by the alkalies of the blood, but this is doubtful.

Post-mortem Appearances.—In these there is nothing characteristic. The lungs and meninges of the brain are usually congested. The blood is said to coagulate less firmly than usual (Richardson). The odour of the drug is perceptible in the viscera.

Fatal Dose.—Great uncertainty exists as to what may be regarded as a poisonous dose, on account of some unexplained

irregularity in the action of the drug. A case is reported by Marshall ('Phil. Med. and Surg. Rep.' 1871) where 3 grains caused the death of a child a year old, in 10 hours. Thirty grains have caused alarming symptoms and death in a woman aged thirty (Fuller, 'Lancet,' March, 1871, p. 226). Reynolds ('Practitioner,' March, 1870) relates a case of nearly fatal poisoning from 45 grains. Watson ('Phil. Med. and Surg. Rep.') reports a case where 80 grains, given in 10-grain doses, over a period of 36 hours, nearly proved fatal. Jolly ('Centralblatt f. die Med. Wissensch.,' 1872, p. 394,) gives two fatal cases of poisoning by 5 grammes (77 grains). Both patients had been in the habit of taking the same dose for several evenings previously, and both died in a few minutes after the last dose. On the other hand, much larger doses have been given without causing serious effects. Anstie ('Practitioner,' 1871, p. 127) relates two cases, one of delirium tremens, where 160 and 180 grains were given; and another of mania, where 120 grains had no other effect than that of inducing prolonged sleep. For other cases see papers by Richardson ('Med. Times and Gaz.' 1871); Hunt and Watkins ('Brit. Med. Jour.,' Feb. 1871); Norris ('Lancet,' Feb. 1871).

Fatal Period.—A quarter of an hour to ten hours or more.

Treatment.—That of opium-poisoning. The patient should be roused by stimulants. Artificial respiration may be necessary. The subcutaneous injection of strychnia has been recommended as an antidote; but its efficacy has not been confirmed by the experiments of the Edin. Committee on the 'antagonism of medicines.'

Chronic Poisoning by Chloral.—Chloral like opium is habitually taken by a large number of persons. It gives rise to gastro-intestinal irritation, and cutaneous eruptions, mostly erythematous, in addition to the other injurious effects of indulgence in narcotics.

The supplemental list which heads this chapter, roughly divided into three groups, according as they are derived from the destructive distillation of coal, wood, or animal matter, or by analogous processes, comprises several important poisons, some of which can only be briefly noticed, the reader being referred for fuller information to works on Toxicology. Their character and mode of action justify their place in this chapter.

Carbolic Acid—Phenol.

The widespread use of this acid in surgery and as a disinfectant has led to many cases of accidental and suicidal poisoning, as well as to fatal results when absorbed from the skin or from wounds dressed with carbolic acid lotions.

Properties.—Carbolic acid is met with in commerce in a crude state in the form of a dark liquid of a peculiar odour, and containing a large proportion of xylic and cresylic acids. When pure it is in the form of colourless acicular crystals, which fuse at 90°, and readily deliquesce on exposure to the air. It is slightly soluble in water, to which it communicates its characteristic odour, as well as in alcohol, ether, and glycerine.

Tests.—*a.* Carbolic acid is recognised by its odour. *b.* When concentrated a slip of deal dipped in it, and afterwards in hydrochloric acid, and exposed to the light, beeomes of a greenish-blue colour. *c.* In dilute solutions perchloride of iron strikes a violet blue colour. *d.* A more delicate test is the pale blue colour which is produced when the solution is treated with a quarter of its volume of liquor ammoniæ, and a clot of chloride of lime added. This reaction requires a little time, and is hastened by heat. *e.* In excessively dilute solutions (1 in 40,000) bromine water in excess causes a yellowish flocculent precipitate of *tribromophenol* which, on being treated with sodium amalgam, yields oily drops of phenol.

In Organic Mixtures.—These smell strongly of phenol, which can be distilled off on dilution and acidulation with sulphuric acid.

Symptoms.—When the poison is swallowed it causes local caustic effects and a burning sensation in the mouth, fauces, and stomach, followed rapidly by vertigo and a feeling of intoxication. This passes into a state of unconsciousness, stupor, and collapse, with complete muscular prostration and anæsthesia, stertorous respiration, rapid and feeble pulse, and cold skin. Vomiting is rare, and convulsions are exceptional. Usually there is marked contraction of the pupil. The odour of the poison is perceptible in the secretions of the nose and mouth and in the breath.

Post-mortem Appearances.—The mucous membranes of the mouth, gullet, and stomach are pale, corrugated, sodden, and partially detached, and marked by local patches of hyperæmia or capillary hæmorrhage. The acid leaves marks on the lips and chin. There is congestion of the brain and its membranes, congestion and œdema or emphysema of the lungs, and congestion of the abdominal viscera. The heart is sometimes full; at others empty; or the right side full, and the left empty. The blood is dark and semi-fluid, or only partially coagulated. The body exhales the odour of the acid, which is very evident in the subarachnoid fluid and cerebral ventricles. The urine is of a dark or olive green tint due to oxidation products of carbolic acid, and has the odour of the acid.

Fatal Dose.—Dangerous symptoms have been caused by 6 or 7 drops of the acid (Fuller and Pinkham). The exact fatal dose

is not determined. Usually the quantity swallowed has been large or indefinite. Half an ounce has caused death in 50 minutes (Jeffreys and Hainworth, 'Med. Times and Gazette,' 1871, p. 423). One ounce has caused death in 30 minutes (Hearder, 'Brit. Med. Jour., 1873, p. 584). Ogston ('Brit. Med. Journ.' Feb. 1871) has reported a case of death in 13 hours from an ounce to two ounces. Taylor ('Phil. Med. Times,' vol. ii. p. 284) gives a case fatal in from 2 to 3 minutes from a dose of about an ounce.

Death has resulted from absorption from the unbroken skin, as when strong carbolic acid lotions have been rubbed in to cure scabies. Hamilton ('Brit. Med. Journ.,' 1873, p. 226) relates a case of death in $3\frac{1}{2}$ hours from the application of carbolic acid to a wound. Consult Machin ('Brit. Med. Journ.,' Feb. 1868) and Hoppe-Seyler (Pflüger's 'Archiv f. Physiologie,' v. 1872).

Fatal Period.—A few minutes (Taylor), 10 minutes (Barlow), 8 hours (Ferrier), 13 hours (Ogston), sixty hours (Zimm).

Treatment.—The stomach should be emptied by emetics or the stomach-pump. Olive oil has been recommended as an antidote. Huseman states that the most efficient antidote is the *saccharate of lime,* made by dissolving 16 parts of sugar in 40 of water, and adding 5 parts of caustic lime. After three days' digestion the mixture is to be evaporated. It is to be given in water in excess.

Benzole or Benzine.—This is a limpid, colourless liquid, of low specific gravity (0·85), with a peculiar and not unpleasant odour, boiling at 177°, and giving off a highly inflammable vapour. It is not soluble in water, and being an excellent solvent for strychnia, is used to separate it from its solutions. Being also a solvent of fats and oils, it is largely used for removing greasy stains. Both the liquid and its vapour possess poisonous properties.

Nitro-benzole (Nitro-Benzine, Essence of Mirbane).

This is an oily liquid, obtained by the action of nitric acid on benzole. It has a pale yellow tint, and an odour like that of oil of bitter almonds, for which it is substituted in confectionery and perfumery. It is also used largely in the arts for the manufacture of aniline. It is insoluble in water, in which it sinks, but is readily soluble in alcohol, ether, and chloroform.

Tests.—It has the odour of bitter almonds, but more persistent. It is distinguished by strong sulphuric acid, which causes no change in it, but strikes with oil of bitter almonds a fine crimson colour. It is insoluble in a solution of sulphate of soda, in which oil of bitter almonds is soluble. (Dragendorff).

Nitro-benzole is converted into aniline by heating it with

acetic acid and iron filings. Acetate of aniline is formed, which may be recognised by the purple colour it strikes with a solution of chloride of lime or any alkaline hypochlorite.

In Organic Liquids.—Nitro-benzole may be separated by distillation, or it may be extracted by ether or chloroform and obtained on evaporation of the solvent.

Symptoms.—Nitro-benzole acts powerfully as a poison whether inhaled as vapour or swallowed. Dangerous effects have been produced by the vapours of soap * prepared with it. It has been taken in mistake for *liqueur*, and in one case reported by Stevenson,† was dispensed instead of rectified benzole, with almost fatal results. Between the inhalation or ingestion of the poison and the development of the symptoms, some hours may elapse—four hours in two cases reported by Letheby. In Stevenson's case the characteristic symptoms did not come on till 48 hours after the commencement of the administration in doses repeated three times a day, amounting in all to 23 minims of nitro-benzole. When the poison begins to take effect there are weariness and headache, passing into heaviness and an appearance of intoxication, the face having a livid hue. Rapidly, in some cases quite suddenly, the individual falls down insensible in complete muscular relaxation, or perhaps with convulsions or tetanic spasms and dilated pupil, the face being livid, the lips purple, and the nails of a bluish tint. Death occurs quietly, or occasionally in convulsions.

Post-mortem Appearances.—There is nothing characteristic of poisoning by nitro-benzole except the odour. There is general venous congestion, and a dark fluid blood as in asphyxia. Letheby has described the liver as being of a purple tint.

According to Letheby, nitro-benzole is changed into aniline in the system, the symptoms being essentially the same, and aniline may be detected in the urine and brain. This, however, has been controverted by recent researches (Filehne ‡). The long continuance of the symptoms is attributed to the slow absorption of the poison from the stomach.

Diagnosis.—The odour of the breath and of the contents of the stomach, and the general symptoms, resemble those of oil of bitter almonds. The chief point of difference is the period of invasion, oil of bitter almonds being almost immediate, nitro-benzole after a variable period of latency.

Fatal Dose.—This is not accurately determined, but a case of death is reported, after a relapse, from about 15 drops. Twenty-three minims in divided doses extending over 48 hours, nearly

* 'Lancet,' Feb. 1862, (Nicholson). † 'Lond. Med. Rec.,' 1878, p, 320.
‡ 'Archiv f. Exper. Path. und Pharmacol.,' Oct. 1878.

caused death in the case reported by Stevenson. The amount in fatal cases by inhalation cannot be estimated accurately.

Treatment.—As nitro-benzole is absorbed very slowly, evacuation of the contents of the stomach by emetics or the stomach-pump even at a late period will be beneficial. When the symptoms are fairly developed, the cold affusion, stimulants, and artificial respiration are indicated. No specific antidote is known.

ANILINE.

Aniline, largely used in the arts for the production of the aniline dyes, is prepared from nitro-benzole by the action of reducing agents, acetic acid and zinc, &c. The aniline dyes are obtained by treating aniline with oxidising agents, of which arsenic acid is the one most commonly employed.

Aniline is commonly met with as a yellowish or brownish oily liquid of an unpleasant odour and burning bitter taste. It has a neutral reaction, but acts as a base and forms white or colourless salts with acids, soluble in water. Aniline is almost insoluble in water or chloroform, but freely soluble in alcohol, ether and oils.

Its watery solutions are characterised by the splendid purple colour, passing into a dirty brownish-red, on the addition of chloride of lime or an alkaline hydrochlorite.

Symptoms.—Whether in liquid or vapour, aniline acts as a poison both in man and animals. The symptoms are essentially those of nitro-benzol, but they appear to commence earlier. For cases see 'Med. Times & Gaz.,' March 8 and June 7, 1862.

No fatal cases are on record. The aniline salts appear to have little or no tonic effects. Aniline dyed fabrics worn next the skin sometimes give rise to painful and obstinate eczematous eruptions; but these have been distinctly traced to the arsenic which they contain.

Oil of Turpentine.—This liquid is possessed of poisonous properties, partly irritant, partly narcotic. Two drachms of the oil have killed a dog in three minutes, the effects showing themselves immediately in staggering, cries, tetanus, and failure of pulse and respiration. It is often given as an aperient, or used as an injection, for the destruction of worms, or to promote the expulsion of flatus from the bowels. In doses of one, two, or three ounces, it has acted only as an aperient; but, in some instances, it has caused violent irritation of the urinary organs, and in others intoxication, followed by coma, collapse, and convulsions. It has more than once caused dangerous symptoms, sometimes described as *intoxication,* in young children.

Kreasote.—This is one of the products of wood-tar. It is named from its property of preserving flesh, and has powerful antiseptic properties. It is used in medicine chiefly for the purpose of checking obstinate vomiting: but it is also employed as a local application to carious teeth, and, externally, in a state of dilution, to fœtid ulcers, and some skin diseases. If applied to the skin it destroys its vitality. It is an active poison. Thirty drops suffice to kill a rabbit in one minute. In the human subject, a large medicinal dose produces irritation of the stomach and bowels, with giddiness, headache, and drowsiness. Two drachms in a single dose have killed an adult in thirty-six hours.

Fousel or *Fusel Oil* (amylic alcohol, potato-spirit, oil of grain).—This liquid, distinguished by its disagreeable odour, burning taste, and irritating vapour, acts as an inebriant, whether swallowed or inhaled, causing headache, giddiness, and staggering gait.

Oil of Dippel.—This animal oil is the product of the destructive distillation of hartshorn, bones, and other animal matters. It has twice proved fatal in the human subject, but under circumstances which have prevented a full description being given of the symptoms. Vomiting was present, and, on examination of the body, there were marks of irritation of the stomach and bowels, and of strong corrosive action in the mouth and gullet.

Coal-naphtha.—This product of the distillation of coal-tar has proved fatal to a boy twelve years old. It was taken in the large dose of three ounces, and death happened in less than three hours. The first symptoms were those of intoxication and furious delirium, soon followed by insensibility, stertorous breathing, and cold skin; then, after partial recovery, following vomiting, fresh symptoms of collapse. Four days after death the body was pervaded by the odour of the poison ('Lancet,' 1856, p. 230).

Nitro-glycerine.—This substance is largely used for blasting purposes, and in alcoholic solution has recently been recommended by Murrell for the treatment of angina pectoris.

It acts powerfully as a poison, both as a liquid and in vapour, both on men and animals, apparently more so on the latter.

In frogs it causes tetanic convulsions, followed by general paralysis.

Small doses in men cause intense headache and violent beating in the temples.

In three fatal cases reported by Nyström,* death occurred in coma without convulsions, after intense dyspnœa and cyanosis.

* Quoted in Ziemssen's 'Cyclopædia.'

CHAPTER XII.

CONVULSIVES.

NUX VOMICA, STRYCHNIA, AND BRUCIA.

THE alkaloid strychnia is the chief active ingredient in severa[l] plants that have the common property of giving rise to symptom[s] of tetanus. It is generally found with another alkaloid, brucia, possessed of similar, but less active poisonous properties.

Strychnia is ascertained to be the active poisonous principle of five plants—all natives of hot climates—the Strychnos nux vomica, S. Ignatia, S. tieuté, S. toxifera, and S. colubrina. The Strychnos nux vomica grows as a tree in Coromandel, in other parts of India, and in Ceylon; the S. Ignatia in the Philippine Islands, also as a tree; the S. tieuté, in Java, as a large climbing shrub; the S. toxifera is a native of Guiana; and the S. colubrina grows as a tree in many parts of Asia. A cutting of the S. nux vomica, with a section of the fruit showing the seeds, is given in fig. 106.

Fig. 106.

The S. nux vomica yields the poisonous seed and bark in use in this country; the S. Ignatia the seed known as the bean of St. Ignatius. The S. tieuté supplies the bark of which an aqueous extract constitutes the upas poison. The S. toxifera was, till lately, thought to be the exclusive source of the poison variously designated as woorara, woorali, oorara, curare, and ticunas, used by the natives of South America in preparing their poisoned arrows. There is now reason to believe that this poison is a compound derived from this and other sources (animal and vegetable).

There are three vegetable productions more or less common in England which contain strychnia—the bean of St. Ignatius, and the bark and seeds of the Strychnos nux vomica.

The *beans of St. Ignatius* are not often seen out of museums. They are the seeds of the pear-shaped fruit of the S. Ignatia, in which they exist to the number of about twenty. They vary in size from that of a nut to that of a large filbert; have a thin brown outer coat, easily detached, and leaving a smooth, black surface. They are very hard, and look like small pebbles with irregular rounded outline, and two or three unequal flattened surfaces. They contain strychnia in the large proportion of 12 parts in 1000, and some brucia, and act like nux vomica or strychnia.

The *bark of the Strychnos nux vomica*, formerly mistaken for cusparia or Angostura bark, and named, accordingly, "false Angostura bark," has a very characteristic appearance. It is quilled, or twisted like dried horn, and is thickly covered with white prominent spots bearing some resemblance to a lichen. It yields a light yellow powder of an intensely bitter taste, which is reddened by nitric acid. It contains both strychnia and brucia, and acts in the same manner as the seed.

NUX VOMICA.

This poisonous seed is largely imported into this country; and a spirituous extract (extractum nucis vomicæ) given in the dose of half a grain to two grains, and a tincture, containing forty-four grains to the ounce (dose ten to twenty minims) are in the British Pharmacopœia. The nut or seed, as well as the alkaloid and its salts, are in common use as poisons for wild animals, rats, and vermin; and they are prescribed as medicines in paralytic affections, and in various other diseases. The nut itself, in powder or extract, is occasionally taken as a poison.

The seeds, three to five in number, are enclosed in a rich orange-coloured fruit of the size and shape of a large apple. They are circular in outline, and vary in thickness, and in size from

that of a shilling to that of a florin. Their edges are rounded; one surface is concave, the other convex, or convex in the centre and deeply grooved near the margin, as in fig. 107. A vertical section has the appearance shown in fig. 108, and a horizontal

Fig. 107.

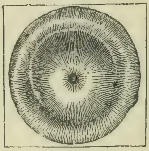


Fig. 108.

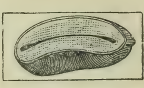
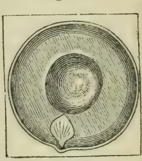


Fig. 109.



section displays a circular central cavity and heart-shaped embryo, as in fig. 109. By introducing a sharp knife at the projecting point shown in fig. 107, the seed may be easily cleft so as to display the embryo. The seeds have a coating of light brown silky hairs, radiating from the centre. They are so hard that they can only be reduced to powder by rasping or filing. When turned in the lathe they yield a white shaving. The interior of the seeds is white or slate-coloured, and of a waxy consistence, and gives a rich orange colour with a drop of nitric acid, and a green with the perchloride of iron.

The powder of the seeds has the colour of jalap powder, a faint odour and an intense and persistent bitter taste. The brown silky fibres which coat the nut, are seen in large numbers under the microscope, and are very distinctly defined when treated with a drop of nitric acid. The watery solution of the powder is rendered pink by nitric acid, and green by the perchloride of iron. The powder contains the alkaloids strychnia and brucia in union with a so-called strychnic or igasuric acid. The quantity of strychnia has been variously estimated at 4 and at 10 parts in the 1000.

The extract is readily recognised by the rich orange colour imparted by nitric acid, the lake colour developed by sulphuric acid, and the transient blue tint given by sulphuric acid and bichromate of potash.

Symptoms.—Those of poisoning by strychnia; combined in some cases with irritation of the alimentary canal.

Commencement of Symptoms.—From five minutes to an hour or even more, according to the form in which it is given.

Fatal period.—From fifteen minutes to three hours or more. One hour is the common period.

Fatal dose.—Thirty grains of the powder, the weight of a nu

of medium size, and three grains of the alcoholic extract, have proved fatal.

Post-mortem Appearances.—Those of poisoning by strychnia. The brown powder often adheres to the surface of the stomach.

Treatment.—After emetics or the stomach-pump, the treatment of poisoning by strychnia.

STRYCHNIA.

This alkaloid is largely used in every part of the world to destroy wild animals and vermin. In poisoning wild animals it is usual to insert it in the stomach of a small animal or bird recently killed; and in poisoning birds to steep grains of wheat in a strong solution of the alkaloid or of one of its salts. A powder known as "Battle's Vermin Killer" contains according to an analysis by Dr. Letheby, 23 per cent. of the poison mixed with flour, sugar, and Prussian blue; and "Butler's Vermin Killer" consists of strychnia mixed with flour and soot, in the lower proportion of about 5 per cent. The flesh of animals that have eaten poisoned meat or grain sometimes proves poisonous to other animals.

Strychnia in the dose of $\frac{1}{30}$ to $\frac{1}{12}$ grain, and the liquor strychniæ containing 4 grains to the ounce, and in the dose of from 5 to 10 minims, are in the British Pharmacopœia. In consequence of this twofold use of strychnia as a popular poison for animals, and as a medicine, cases of accidental poisoning sometimes occur. Of late years, too, the alkaloid has become a formidable instrument in the hands of the murderer; and is believed to have been the immediate cause of death in more than one recent instance. On an average of years, strychnia and nux vomica are credited with two deaths.

Strychnia may have to be examined—1. In substance. 2. In solution. 3. In organic mixtures.

1. *In Substance.*

Properties.—Strychnia is found in commerce as a white powder, and as a colourless crystal. In commercial specimens the form of the crystal is a rectangular prism, either perfect, or with the ends replaced by one or two oblique planes. When obtained from solutions of its salts by addition of liquid ammoniæ, or, still better, by exposure to its vapour, they present under the lens or microscope three leading forms—the long rectangular prism, the short hexagonal prism, or the regular octahedron. From a group of crystals

obtained by exposing a drop of the solution of the acetate of strychnia to the vapour of ammonia, the forms shown in figs. 110 and 111 have been selected.* The crystals in fig. 110 are long four-sided prisms, isolated or in stellate groups, with a single octahedron shown in contact with one of the prisms. The crystals in fig. 111 are either regular octahedra, or modifications of the same, or short six-sided prisms; and there are one or two dodecahedra, rhomboidal and pentagonal, as well as plates of different forms,

Fig. 110.

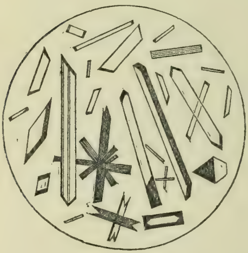
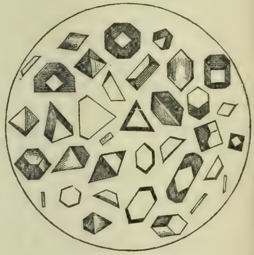


Fig. 111.



and among them one of the deep triangular plates so common in some specimens of arsenious acid. The octahedra will be recognised in the several points of view in which they present themselves, on referring to the account given of the crystals of arsenious acid in the Appendix.

Strychnia has an intensely bitter and very persistent taste, stated to be distinctly perceptible in solutions containing one grain of the alkaloid in a gallon (70,000 grains) of water. Strychnia is so insoluble in water as to require for its solution upwards of 7000 times its weight, at 50° (one grain in about fourteen measured ounces), and 2500 times its weight at 212°. Wormley gives, as the result of many experiments, one in 8333 parts of water. But it is more or less soluble in ether, alcohol, amylic alcohol, benzole, and chloroform. It is soluble in about 1000 parts of commercial ether, 200 of absolute alcohol, 120 of amylic alcohol, 250 of benzole, and 8 of chloroform. If pure, the strong mineral acids do not colour it; but when it contains brucia, nitric acid more or less reddens it. When heated on porcelain, it melts slowly into a dark brown liquid, smokes abundantly, gives out an agreeable odour, and deposits a moderately abundant carbon.

* Acetate of morphia similarly treated yields prismatic forms only (fig. 88, p. 514.

Tests.—*a.* The form of the crystals as above described. *b.* The intensely bitter taste. *c.* The very sparing solubility in water. *d.* The negative effect of strong sulphuric acid. Strychnia belongs to the group of alkaloids which are not changed in colour by cold sulphuric acid. Nor is any colour developed when the acid solution is warmed, and only a light yellow tint when it is heated. *e.* The chemical and galvanic colour tests. *f.* The test of sublimation.

The Colour Tests.—1. Chemical Colour Tests. *a.* Place the smallest visible crystal or granule of strychnia on white porcelain, or enamelled glass. Add a drop of pure strong sulphuric acid, and mix the acid and alkaloid thoroughly with a glass spatula. No change of colour takes place; or, if it contain brucia, a faint rose tint. Near this acid mixture place a speck of bichromate of potash, and then bring the liquid and the reagent together with the point of the spatula, having previously placed the porcelain in a favourable light. At the point of contact a deep rich blue colour makes its appearance, and on stirring the reagent into the acid solution, extends through the whole liquid, which soon changes to purple, from purple to crimson, from crimson to a rich red brown, and then gradually fades into a bright red, which colour it retains for several hours. *b.* Proceed in the same manner with ferricyanide of potassium. *c.* Proceed in the same way with the permanganate of potash. *d.* Place a drop of strong sulphuric acid on the white porcelain; add a minute fragment of the peroxide of manganese (not more than will impart to the acid when mixed with it a neutral tint). Draw out a thin line of this acid liquid with the point of the spatula, and bring it in contact with a minute granule or crystal of strychnia. Similar colours will appear wherever the alkaloid is brought in contact with the mixture. *e.* Proceed in the same way with the peroxide of lead. The same colours will be developed. The description of the colours produced by these reagents may be simplified and more easily remembered if, intermediate shades of colour being overlooked, the succession is described as—1. The rich blue of the Orleans plum; 2. The darker purple of the mulberry; and 3. The bright clear red of the sweet orange. Of these colours, when the reaction is normal, and the colour-developing substance is at once stirred into the acid liquor, the first lasts from half a minute to forty-five seconds, the second colour, one, two, or three minutes, and the third for several hours or days. So that it is not of a mere flash of colour that we speak when describing the colour-tests, but of a successive change of colour that can be deliberately watched and readily recognised.

These tests all give highly satisfactory results, but the most

delicate is the permanganate of potash.* Sonnenschein recommends the sesquioxide of cerium and sulphuric acid as a very delicate test for strychnia. Employed in the same manner as the above tests it causes a beautiful blue, which passes slowly into violet, and finally into a cherry-red, which lasts a long time ('Archiv der Pharmacie,' cxciii. 252).

The colour tests are equally applicable to crystalline spots obtained by evaporating solutions of the alkaloid, or of its salts; and they react with the greatest delicacy and certainty on the sublimates presently to be described.

2. Galvanic Colour Test.—This also is applicable to a crystal or granule of strychnia, or to a deposit of the alkaloid from its solutions. Place a drop of a solution of strychnia (say one part of the alkaloid in 10,000, or even 20,000, of water) into a cup-shaped depression in a piece of platinum foil, and allow it to evaporate. When dry, moisten the spot with a drop of concentrated sulphuric acid. Connect the foil with the positive pole of a single cell of Grove's or Smee's battery, and then touch the acid with the platinum terminal of the negative pole. In an instant the violet colour will flash out, and on removing the pole from the acid the tint will remain (Letheby.)

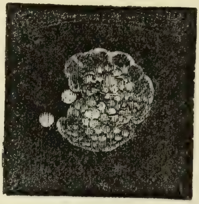
The Test of Sublimation.—This also is one of extreme delicacy, succeeding best with such minute quantities as the $\frac{1}{100}$th down to the $\frac{1}{10000}$th of a grain. The larger quantity will yield fifteen or more successive sublimates; the smaller, at least one distinct one. The coarser sublimates from the larger quantity will also yield characteristic secondary sublimates. This procedure, too, is applicable to the alkaloid as deposited from its solutions.

The mode of procedure is that described and figured at p. 443 fig. 65. A fragment of crystal, or a speck of powder, is placed on a clean dry crucible cover, in the centre of a ring of glass. A glass disk, or microscopic slide, is dried and heated in the flame of the spirit-lamp, and placed on the ring. The flame is then applied to the porcelain till its temperature is considerably raised, when a mist will appear on the glass disk, and upon this, one by one, several milk-white circular spots, remaining distinct, or coalescing. These are often crystalline, as seen by the naked eye, and in good specimens have the appearance shown in fig 112. Similar appearances occur (though less uniformly) in the sublimates of morphia, and they afford a strong presumption of

* For a careful examination of the colour-tests for strychnia, and reasons for preferring the solid to the liquid form of the soluble reagents, see a Paper by Dr. Guy in the 'Pharmaceutical Journal,' 1861. See also the same Journal, July, 1856, for an instructive Paper by Mr. W. Copney.

the presence of strychnia. To such a sublimate as is here shown, and, indeed, to sublimates that are much less characteristic, the colour tests, as well as all the liquid tests which give good results with strychnia, or its solutions, may be applied with confidence. The parts of the sublimate which are least characteristic should be chosen, and to these the several reagents should be applied in succession under the microscope, the more characteristic crystalline appearances remaining intact.

Fig. 112.



When this sublimation is so conducted as to determine the temperature, strychnia is found to remain unchanged up to about 345°, when it begins to yield sublimates. At 430° it melts, and continues to yield sublimates till it is exhausted, and reduced to a carbonaceous film.

The sublimates, examined under the microscope, assume many forms. They may consist of drops, or waving patterns, colourless, or discoloured, as if smoked; but the greater number are more or less crystalline.

Fig. 113.

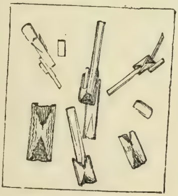
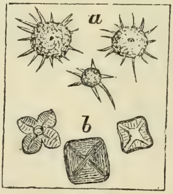


Fig. 114.



Crusts obtained at high temperatures, with the glass disk suitably heated, consist of characteristic isolated crystals, such as are obtained from liquid solutions (fig. 113), or they may contain such crystalline forms as are depicted at *a* and *b*, fig. 114.

An amorphous centre, with penniform or lattice-shaped border is not uncommon, and it may be stated generally that while the sublimates of morphia (fig. 89, p. 515) are made up of curved lines, those of strychnia consist (as in fig. 115) of lines either straight or slightly curved, with parallel feathery lines at right angles.

In the coarser crusts, the dark spots, or feathered crystals mentioned as occurring in the sublimates of morphia (p. 515), are often to been seen lying on the slide, or projecting from it. They present such forms as are shown in fig. 116.

Fig. 115.

The sublimates of strychnia, then, assume so many forms* that they are not in themselves conclusive of its presence; but it fortunately happens that there is no form that does not give with certain liquid reagents results which prove the existence of strychnia beyond the reach of doubt.

In the first place, as already stated, the colour tests act on the sublimate with extreme delicacy; so that to a small spot consisting of the $\frac{1}{10000}$ th of a grain all these tests may be applied with ease and certainty, minimum drops of sulphuric acid being used, and the smallest visible speck of the colour-producing substance.

Fig. 116.

A second reaction of like delicacy is obtained by touching some portion of the sublimate which happens to present the least characteristic appearance with a minimum drop of an aqueous solution of carbazotic acid ($\frac{1}{250}$). Immediately, or in a few seconds or minutes, small round greenish brown spots show themselves, which spread and often coalesce, and become the centres of the delicate arborescent crystalline groups, shown in different degrees of delicacy in figs. 117, 118, and 119.

Fig. 117.

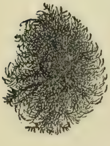


Fig. 118.

It will be observed that the elementary form in all these figures is a hook or claw, or large section of a small circle. This is a rare form, and an eminently characteristic reaction; and it is one which I propose with confidence as a test for

* See these forms described and illustrated in a Paper, at a meeting of the Royal Microscopical Society,' Oct. 1867, and published in its Journal (G.)

strychnia, both delicate and safe, and *probably* peculiar to this alkaloid; but if not, certain to be shared with very few other substances.

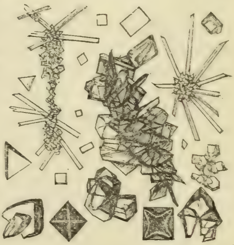
A third reaction, which is both delicate and of uniform occurrence, is that with the bichromate of potash. An aqueous solution of this substance $\frac{1}{100}$ (which, when dry, displays the delicate arborescent form depicted in fig. 86, p. 509, often instantaneously, always speedily, developes isolated yellow plates, generally square or oblong, or groups such as are shown in fig. 120.

Fig. 119.

This reaction, too, is either peculiar to strychnia, or likely to be shared with very few other substances.*

These statements, though made with caution and reserve, are founded on experiments (in some instances often repeated) on a large number of alkaloids and analogous active principles. But it should be borne in mind that the sublimates of the alkaloids must needs resemble those of the inorganic poisons as well as crystals deposited from solutions, in being subject to great variety of form, as well as to success and failure; that the evidence of the presence of poisons is always cumulative; and that objections may be made to almost every reaction if taken by itself.

Fig. 120.



In the case of this test of sublimation, the evidence would be of this kind. A speck of white powder or crystal believed to be strychnia, or a minute deposit from a solution in chloroform or benzole, or from a solution of a salt of strychnia neutralized by the vapours of ammonia, is so sublimed as to ascertain the temperature. The thermometer rises gradually beyond 200°,

* See for many minute details on this subject five successive Papers in the 'Pharmaceutical Journal,' from June to October, 1867 (G.).

212°, 240°, and 280°, at which corrosive sublimate, cantharidin, calomel, and arsenious acid, respectively sublime; and beyond the melting point of the other poisonous alkaloids, till at or about 345° it yields a sublimate or sublimates, melts at 430°, and still yields sublimates, till at length it is exhausted and reduced to a charcoal spot. Now all the alkaloids, and analogous active principles, liquefy and sublime, and leave a deposit of carbon; but no other among the poisonous alkaloids answers in any degree to the description now given except morphia. But this substance under experiment yields the white spotted sublimate described and depicted in fig. 112, and in this, again, corresponds with either strychnia or morphia; and, when examined by the microscope, shows the crystalline forms that belong rather to the former than to the latter. If now we submit the sublimate to the colour tests for strychnia, it displays the typical succession of colours; and if the slightest doubt or misgiving could remain, there would still be in reserve the remarkable, and probably quite characteristic, reactions with carbazotic acid and bichromate of potash.

2. *In Solution.*

The process for extracting strychnia from organic mixtures presents the poison, not as an aqueous solution, but dissolved in ether, benzole, or chloroform. The strychnia so held in solution is allowed to deposit itself on a glass disk or slide, examined by the microscope, and then submitted to the action of the various tests. If one or more of these deposits be treated with dilute acetic acid, a soluble acetate of strychnia is formed, to which the liquid tests may be applied. Assuming this procedure to be adopted, the form of the deposits from the solutions of strychynia in ether, benzole, and chloroform will be first described, and then the effect of certain chemical tests on the solution.

Strychnia in Ether, Benzole, and Chloroform.—*a. In ether.* This crystalline deposit usually assumes dendritic forms; but it may contain octahedra and four-sided prisms. *b. In benzole.* The solution of strychnia in benzole sometimes leaves on evaporation crystals of great brilliancy, distinctness, and permanence. The short six-sided prism is the prevailing form: but triangular and other plates of various thickness, and dodecahedra, rhomboidal and pentagonal, are occasionally met with, as in fig. 111, p. 562. Generally, however, the deposit, though crystalline, does not present distinct crystals, even when the strychnia and benzole are apparently pure. *c. In chloroform.* The alkaloid is deposited from this solution as rosettes, veined leaves, stellate dotted

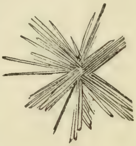
needles, circles with broken radii, and branched and reticulated forms of great delicacy and beauty. Solutions of strychnia in alcohol deposit forms similar to those yielded by the ethereal solution. (Fig. 121.)

Fig. 121.

Other Chemical Tests.—Several chemical reagents have been recommended as tests for strychnia; of which some, as the solution of iodine and iodide of potassium, and tannic acid, are tests for the alkaloids as a class, others sufficiently characteristic to deserve special notice.

1. The acetate of strychnia itself to a weak solution of which the tests are supposed to be applied, crystallizes in tufts of needles (fig. 122).

Fig. 122.



2. *Carbazotic acid*, a solution of which of the strength of $\frac{1}{250}$ has been already described as a delicate and characteristic test of the strychnia sublimate, is equally applicable to the solution of its salts. A drop of this reagent added to a drop of the solution first occasions an abundant gelatinous deposit, which gradually gives place to curved crystals waving in the liquid, like tufts of grass, and presenting when dried the curved and often delicately feathered forms of fig. 123.

Fig. 123.

3. A solution of *corrosive sublimate* causes an abundant white precipitate, which assumes the highly characteristic crystalline form depicted in fig. 124.

Of other reagents it may be observed that there is no alkaloid which yields so many well-marked reactions with the many tests that have at different times been recommended.*

All the general reagents for alkaloids (p. 397) yield with solutions of the salts of strychnia distinct precipitates, most of which assume, either instantaneously or speedily, crystalline forms;

* Refer to Papers by Dr. Letheby, in 'Lancet,' June 28, and July 12, 1856; and to Wormley's 'Micro-Chemistry of Poisons.'

sometimes as the first effect of the contact of the two liquids; but sometimes they are developed out of flocculent or gelatinous masses.

Fig. 124.

All these reactions of strychnia, as of the other alkaloids, may be studied with advantage in single drops of their solutions placed on glass slides or disks, and touched with smaller drops of the reagents:—a simple and delicate method which ought to supersede the coarser procedure of the test-tube; and which has the obvious advantage over it, of presenting every change of form and colour in a state suitable for microscopic examination.

In applying the foregoing tests, it should be borne in mind that the crystalline forms described or depicted are not uniform in their occurrence; and that differences in temperature, in the strength of the solution of strychnia, and in the strength and purity of the reagents, as well as in the quantity of the reagent left unexpended, modify the forms of the crystals.*

The Physiological Test.—This name has been given to a test first proposed by the late Dr. Marshall Hall, who directed that frogs recently taken from a pond should be chosen; that the skin should be dried with blotting-paper; and that the liquid to be tested, being a strong solution of a salt of strychnia, should be dropped on the back. In a short time the frog thus treated became affected with tetanoid or epileptoid spasm, or convulsions. He found that this test could detect as small a quantity as $\frac{1}{5000}$th grain of the poison; and he thought that if inserted under the skin, or injected into the stomach, a still less quantity might be detected. The delicacy and certainty of this test have been fully confirmed by Dr. John Traill,† Dr. George Harley, Dr. Wormley, and others. Dr. Wormley ‡ gives an account of some experiments on a small species of frog (the Rana halecina), from which it appears that when a solution of strychnia was introduced into the stomach, quantities of strychnia much less than $\frac{1}{5000}$th grain produced characteristic effects.

After the application of a solution to the skin of the back, or better, subcutaneous injection, in a period of time varying from one or two minutes to a quarter of an hour or more, the characteristic tetanic convulsions show themselves, and recur every time the table is shaken, or the frog touched. In many

* It may be worthy of note, as bearing on this subject, that the depth of a drop of liquid may determine the form of the crystals deposited by it.

† 'Lancet,' July 12, 1856. ‡ 'Chemical News,' April 23, 1860.

cases the frog utters a shriek or cry expressive of pain. When the dose is large, the symptoms show themselves almost immediately, and death takes place in a few minutes. When the dose is smaller, the symptoms come on after an interval of a quarter of an hour, or half an hour, and the animal may recover. The characteristic symptom is generally ushered in by a state of evident distress, with panting respiration and protruding eye.

3. *In Organic Substances.*

Strychnia may be extracted from organic substances by the Stas-Otto process described above (p. 396). In the case of strychnia, chloroform (Rodgers and Girdwood) or benzole (Bloxam) may be advantageously substituted for ether as the solvent. Both are better solvents of strychnia than ether, and benzole, though a less perfect solvent than chloroform, has the two-fold advantage of being lighter than water, and leaving a crystalline deposit of a more marked character. Graham and Hoffmann have shown that strychnine may be separated from beer containing it by means of animal charcoal. The beer is mixed with charcoal and allowed to stand, with frequent shaking for twelve or more hours. The charcoal is then washed with water; boiled with alcohol; the alcohol evaporated, the residue, made alkaline with caustic soda, and shaken up with ether. Strychnia is left in a condition fit for the application of tests.

Strychnia may be detected in the contents of the alimentary canal, in the muscles and viscera, and in the blood and urine. Gay ('Centralblatt f. die Med. Wissensch.,' 1867, p. 49) has been able to detect it in the pons Varolii, medulla oblongata, and spinal cord. Messrs. Rodgers and Girdwood also state that they detected it in the bones. There is no doubt that strychnia, like arsenic, antimony, and mercury, undergoes no change in the alimentary canal, in the vessels of the body, or in the secreting organs; but that it can be detected in them by chemical research skilfully conducted. Nor does strychnia suffer decomposition in bodies which have undergone putrefaction; for Rieckher obtained evidence of its presence in tissues mixed with small quantities of the poison after eleven years' decomposition in open vessels. (*See* Falck, 'Die Wirkungen des Strychnins,' 'Sammlung Klin. Vorträge,' No. 69, p. 562.)

Experiments on Animals.

A large dose of a salt of strychnia in solution may begin to act almost immediately, and kill in a minute and a half. A smaller

dose may produce no effect for several minutes, nor prove fatal for twenty minutes or half an hour; or severe symptoms may be developed, and yet the animal recover. The symptoms are well shown in the following instance:—To a full-grown healthy rabbit, recently fed, a quarter of a grain of sulphate of strychnia dissolved in a few drops of distilled water was given. After the lapse of fifteen minutes the animal appeared easily startled, and was tremulous, and unsteady on its legs. Soon afterwards it trembled violently, or started when touched; and slight twitchings occurred in the limbs on its attempting to move, or when a noise was made. After the lapse of eighteen minutes, when gently lifted by the ears from the table to the floor, it was violently convulsed. The hind and fore legs were rigidly stretched out; the eyes protruded; the breathing was difficult; the pulsations of the heart could not be counted; the head and tail were drawn backwards, as if by a tightened bowstring, with occasional slight intervals of relaxation; and in this state it died, two minutes after the commencement of the convulsions, and twenty minutes after taking the poison. Immediately after death the whole body was flaccid; but it speedily stiffened, and the fore limbs altered their position, and were rigidly stretched out. In eight minutes, while the body was still warm, the muscles were rigid over the greater part of the trunk. On inspecting the body, the lungs were found collapsed, and of a bright red colour; the heart contained blood, chiefly coagulated, on both sides; the blood in all other parts of the body was liquid, and dark coloured.*

Nearly all animals are affected by strychnia in a similar manner. Some birds, and particularly hens, are less susceptible to its action; and a species of sloth (Cholœpus Hoffmannii) seems to be little affected by it (Peters, in Reichert and Du Bois-Reymond's 'Archiv,' 1868, p. 755). It is said that some monkeys enjoy immunity from the poisonous effects of strychnia.

Frogs, as has been stated, are very sensitive; and hence are commonly used as delicate physiological reagents.

Strychnia specially affects the spinal cord, the reflex excitability of which it enormously increases. Hence the tetanic spasms brought on by the slightest sensory impression. It also seems to stimulate the vaso-motor centre, causing contraction of the vessels and increased blood pressure. Death is the result either of asphyxia from the fixation of the muscles of the chest, or of the exhaustion of the nerve centres from excessive activity.

* For an account of this experiment on animals, and a collection of several cases in the human subject, with an examination of the case of Palmer, see Dr. Taylor's Essay, reprinted from the 'Guy's Hospital Reports.'

Crum Brown and Fraser have shown that the action of strychnia is entirely altered when converted into ethyl and methyl substitution compounds. These, like curara, cause general muscular paralysis by acting on the motor nerves.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—In a few minutes to an hour or more after swallowing a substance which, if in solution, would have a hot and intensely bitter taste, the symptoms of poisoning set in with a feeling of suffocation and complaint of want of air. These feelings are soon followed by twitchings of the muscles, with cramps and jerking movements of the head and limbs, which shortly become heightened into tetanic convulsions. The arms are flexed and tightly drawn across the chest, the legs forcibly extended and widely separated, and the feet often turned either inwards or outwards, the head bent back, and the whole body arched so as to rest on the head and heels (*opisthotonos*). The muscles of the abdomen are rigidly contracted, respiration is suspended, the pulse is very rapid, the face is livid and congested, the pupil (in the fit) is usually dilated, the eyes prominent and staring, and the features drawn into a grin (the *risus sardonicus*). The patient complains of a choking sensation, and of thirst and dryness of the throat; but the effort to drink often occasions rigid spasms of the muscles of the jaw. Sometimes there is foaming at the mouth, and the froth may be tinged with blood. After the spasms have lasted one or two minutes there is a short remission, and the patient lies exhausted and bathed in sweat, and able to converse and swallow; for the jaw is not always fixed, even in the fit. The fits sometimes return without apparent cause, but they may be brought on by the slightest touch, or the least effort. The mind is generally unaffected till towards the fatal termination, and may even continue clear to the last. The patient is generally quite conscious of his danger, and aware of the approach of the fits, which he announces by screams or shrieks, or by calling out that "they are coming;" and he often asks to be held, moved, or turned over. Towards the fatal termination, the fits become more frequent and severe, and the patient dies exhausted, or suffocated, in most cases within two hours of the commencement of the symptoms. If a patient survive that period there would be fair hope, but no certainty, of recovery.

The *Post-mortem Appearances* are neither characteristic nor uniform. As a general rule, the body is relaxed at the time of death, but stiffens soon afterwards, and remains rigid for a long time. In some cases it retains the posture of the last fatal spasm. The

hands are usually clenched, and the feet arched, or turned inwards. There is usually some lividity about the face, trunk, and limbs. The expression of the countenance is sometimes quite natural. The internal appearances consist in congestion of the brain and spinal cord, of the lungs and air-passages, and sometimes of the mucous membrane of the stomach. In some cases the heart is contracted, and all its cavities empty; in others the right side is full of blood. The blood throughout the body is black and fluid. The urinary bladder is empty.

Treatment.—The stomach should be immediately evacuated by emetics, or (if practicable) by the stomach-pump, and at the same time solution of tannin, or of iodine in iodide of potassium, may be introduced with a view to precipitate the poison. Various methods have been recommended for the treatment of the fully-developed symptoms. Of these the most satisfactory are chloroform inhalation, or the administration of chloral hydrate either by the mouth or, better, by subcutaneous injection. The experiments of the Edin. Committee, as well as cases of poisoning in man successfully combated, show that chloral, if given in time, antagonises the action of strychnia.

Calabar bean has been recommended as directly antagonistic to strychnia, but the researches of the Edin. Committee show that though it modifies the convulsive effect of strychnia, it does not succeed in saving life.

Curara, also recommended by some, is not a physiological antagonist to strychnia. It can only succeed in preventing the tetanic spasms by directly paralysing the motor nerves. There must therefore be a danger of double poisoning. Combined with artificial respiration, however, it might prove successful. Artificial respiration alone has been found efficacious by Leube and Rosenthal. Infusions or enemata of tobacco have also been credited with success both as antagonising the tetanic influence of strychnia and causing vomiting. Various other agents have been suggested, but most reliance is to be placed on chloral.

Commencement of Symptoms.—From a few minutes to more than an hour. In one case, three minutes; in another two hours and a half.*

Fatal Period.—Shortest, ten minutes; longest, six hours.

Fatal Dose.—A quarter of a grain of strychnia may destroy life; but patients have survived doses of twenty grains or more.

Diagnosis.—The symptoms of poisoning by strychnia are closely allied to those of the disease known as tetanus or locked-

* Wormley, 'Micro-Chemistry of Poisons,' p. 538.

jaw. In poisoning by strychnia, as in tetanus, there are violent paroxysms of rigid convulsion, with intense suffering; and in both the mind is little if at all affected; and when it does suffer, it seems to be the result of the exquisite torture the patient has undergone.

The differences between the disease tetanus, and poisoning by strychnia, are well marked. In this country, and in temperate climates, tetanus is rare, except as the consequence of a wound or severe mechanical injury. In tetanus the symptoms are at first obscure, and develope themselves gradually: in poisoning by strychnia they are strongly marked at the onset, and attain their full development in a few minutes. Tetanus begins with difficulty of swallowing, and stiffness of the jaws and neck, the trunk, legs, and arms being attacked in succession. In poisoning by strychnia, all, or nearly all, the voluntary muscles are attacked at the same time; and the muscles of the jaw are not only not affected first, but sometimes wholly escape, or are violently contracted only during efforts to swallow. In tetanus, opisthotonos does not occur till after some hours or days: in poisoning by strychnia, it is among the early symptoms. In tetanus, the symptoms undergo abatement, but there is no perfect intermission: in poisoning by strychnia, there are intervals of complete intermission. In tetanus the patient dies after the lapse of several hours or days, or recovers slowly after several days or weeks: in poisoning by strychnia death happens in from less than a quarter of an hour to less than three hours after the first appearance of the symptoms (death after such a period as six hours being very rare), or the patient recovers in a few hours. Tetanus brought on by direct injury to the nervous centres sometimes destroys life in a few hours.

The tetanic symptoms caused by strychnia are distinguished from those which occur in the course of poisoning by other substances, irritant or narcotic, inasmuch as in the former case they constitute the only symptom, while in the latter they occur after other symptoms of poisoning have shown themselves; or they are mixed up with them. To this rule, however, it is possible that the salts of morphia may form an exception. (See p. 525).

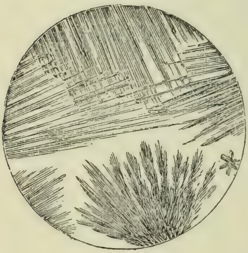
The tetanic convulsions of hysteric and epileptic seizures are similarly distinguished from those of strychnia-poisoning, by forming only a part of the fit. These seizures, moreover, are not in themselves fatal. Death from hysteria is unknown, and it very rarely follows immediately or speedily on an epileptic seizure. There is a marked difference, also, in the character of the convulsive movements. Strychnia produces a rigid tremor, uniformly continuous throughout the paroxysm; whereas in epileptic, epilep-

tiform, or hysteric convulsions, the muscles are alternately relaxed and contracted. The tetanic paroxysm is distinguished by uniform *rigid tremor*, the epileptic or hysteric fit by *jactitation.*

BRUCIA.

This alkaloid derives its importance from being associated with strychnia in the seed and bark of nux vomica, and in St. Ignatius' bean. It has the same poisonous properties as strychnia, but in a less degree, variously estimated at a sixth or a twelfth.

Fig. 125.



Properties.—Brucia is usually found as a white powder; but it is readily crystallized in needles, or four-sided prisms. When thrown down by ammonia from a solution of the acetate, it presents itself in long crossed needles, or in tufts as in fig. 125. Both forms are obtained from the same solution by the same reagent at the same time; the needles from a drop spread over the disk, the tuft from a deep undisturbed drop.

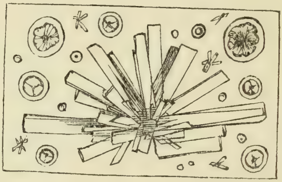
Brucia belongs to the group of poisons which is not changed in colour by cold sulphuric acid; and, like strychnia, it undergoes no change when the acid solution is warmed, but when heated, it assumes a deeper tint of yellow than strychnia. It is at once distinguished from strychnia by the intense red colour which it strikes with nitric acid—a colour toned down to a faint rose tint when the brucia or the nitric acid is present in very small quantity.

Brucia, when heated on white porcelain, melts easily into a pale liquid, darkens, yields a dense vapour, and swells into a moderately abundant carbon. It gives an odour as of burnt horn. When treated in the manner described in the Appendix at p. 668, it melts at 240° Fahr., and sublimes at 400°. The sublimates are rarely crystalline, and are not characteristic. A solution of carbazotic acid ($\frac{1}{250}$) developes in the sublimates root-like forms. It is more soluble in water than strychnia, slightly soluble in ether, very soluble in alcohol, chloroform, and benzole. Its aqueous solution has an intensely bitter taste. With acids it forms salts.

Tests.—a. Nitric acid, as just stated, imparts to brucia and its salts a rich red colour. This red solution, if warmed and allowed

to cool, is changed to purple by protochloride of tin, and bleached by an excess of the solution. *b*. Sulphuric acid, followed by bichromate of potash, developes a red or reddish-brown colour, passing to green and yellow.

Fig. 126.



In the quickness and beauty of its reactions with liquid tests, brucia is second only to strychnia. Fig. 126 shows a group of crystals under a low power of the microscope from an acid solution of brucia with a solution of corrosive sublimate ($\frac{1}{100}$). Results of rare beauty are obtained with red prussiate of potash ($\frac{1}{250}$).

CHAPTER XIII.

DEPRESSANTS.

I. HEMLOCK. II. TOBACCO. III. LOBELIA INFLATA. IV. THE CALABAR BEAN. V. CURARA.

ALL these poisons produce a remarkable weakness, or paralysis of the muscular system; some, as Calabar bean, acting centrally on the cord, others, of which curara is the type, specially on the motor nerves.

I. CONIUM (*Conium maculatum; Hemlock; Common or Spotted Hemlock*).

This plant grows in hedgerows all over England. It belongs to the natural order Umbelliferæ, or parsley tribe, to which also belong the Æthusa cynapium, or fool's parsley, the Cicuta virosa, or water hemlock, the Œnanthe crocata, or water dropwort, and the Œnanthe phellandrium, or fine-leaved water dropwort—all (with the exception probably of the first named) poisonous plants.

Hemlock is readily recognised by its tall glossy green stems, dotted with brownish-purple spots. Its root is tapering, like that of the parsnep, and its leaves have been often mistaken for those of parsley. The seeds of the conium maculatum are of the size and shape shown in fig. 127, and weigh about twenty to a grain; these are distinguished from other seeds of the Umbelliferæ by the presence of five prominent wavy ridges (fig. 128), and the absence of the linear receptacles for volatile oil termed *vittæ*. Every part of the plant has a strong unpleasant mousy odour, which is strongly developed when the plant is rubbed with liq. potassæ. The leaves and fruit are in the British Pharmacopœia. The powdered leaf supplies a poultice; the fresh leaves and young branches yield the extract, and the fresh leaves the succus, conii.

Fig. 127.

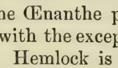
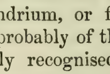


Fig. 128.



The recent investigations of Dr. John Harley* have shown that, with the exception of the "Succus," these preparations are either inert, or, to be effective, must be given in doses very many times larger than those of the British Pharmacopœia. The succus, in a dose of two drachms, produces the characteristic effect on the voluntary muscles. The root is described as quite inert.

The leaves are the parts of the plant usually taken as a poison, commonly in mistake for parsley.

Conium owes its activity to an alkaloid *conia* which may be extracted from all parts of the plant, especially the seeds, leaves, and young shoots.

When pure, it is an oily, volatile, colourless, liquid; but turns yellow, and darkens by keeping. It has a pungent odour, compared to stale tobacco or mice, and gives a greasy, pink stain to filtering paper. It is very soluble in alcohol, ether, and chloroform, but only sparingly in water. A watery solution becomes turbid on heating. This, *inter alia*, distinguishes it from nicotine. With acids it fumes, and forms salts soluble in water, and alcohol. From its salts conia is set free by alkalies, and can be distilled over by heating. It gives precipitates with the general reagents for alkaloids.

There is no very characteristic reaction for conia. Many which have been described depend on impurities or decomposition products. Commercial conia is not altogether uniform in composition.

Compared with nicotine, conia is distinguished by the readiness with which it forms needle-shaped crystals with hydrochloric

Fig. 129.

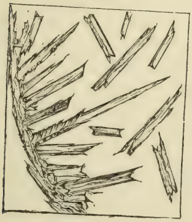


Fig. 130.

acid, whereas the nicotine salt is at first amorphous, and only becomes crystalline after long standing.

The precipitates which conia forms with the general reagents for

* See a series of Papers in the 'Pharmaceutical Journal,' from January to August, 1867.

alkaloids are more soluble than those of nicotine, so that in dilute solutions reagents which precipitate nicotine cause no precipitate in solutions of conia. This is more especially true of chloride of platinum and chloride of gold.

The precipitate of conia with bichloride of mercury is amorphous, that of nicotine consisting of groups of truncated plates, radiating from a centre, or winged forms. With carbazotic acid (1 in 250) conia developes the crystalline forms (fig. 129), differing from the delicate forms arising from a similar reaction with nicotine (fig. 130.)

Ammonia, like conia, forms crystals with hydrochloric acid, and also with oxalic acid. The ammonia salts differ from those of conia by being insoluble in alcohol, which readily dissolves the conia salts; and the crystals of hydrochlorate of conia differ from those of the hydrochlorate of ammonia, in being doubly refractive and giving a beautiful play of colours with the polariscope.

Conia may be separated from organic mixtures by the Stas-Otto process (p. 396), or it may be distilled over after rendering the matters strongly alkaline with caustic soda.

Experiments on Animals.—Experiments on animals have shown that *Conia* acts on all classes of animals as a most energetic poison. The symptoms differ in cold and warm blooded animals. In frogs it causes universal paralysis and death without convulsions. In warm blooded animals the gait becomes insecure, and general paralysis ensues. Death is preceded by clonic convulsions. In one of Wormley's experiments, a single drop was placed on the tongue of a large healthy cat. In a few seconds the animal stood still, and showed an unsteady gait when disturbed. In two minutes and a half it fell on its side, voided urine, had strong convulsions and universal tremor, and died in three minutes. Like curara it paralyses the ends of the motor nerves and afterwards their trunks. It also seems to have a direct action on the spinal cord (Verigo) to which the convulsions and paralysis are in some measure due. It is said not to have any direct effect on the brain or sensory nerves, but observations on man show that applied locally it dulls sensibility. The pupils in poisoning by conia are usually said to be dilated. Burman observed this only during the convulsions. Death is due mainly to asphyxia, the result of paralysis of the respiratory muscles.

Symptoms.—Dryness and constriction of the throat, followed speedily by great muscular prostration, showing itself in a heaviness of the eyelids and confusion of vision owing to impaired adjustment of the ocular muscles. The muscular

weakness becomes pronounced first in the lower extremities, causing a staggering gait and ultimately complete paralysis. The paralysis extends upwards and affects the upper extremities and the respiratory muscles. Respiration becomes difficult, and there is great præcordial anxiety. The pulse as a rule is slow. In further stages convulsions occur and death takes place with all the phenomena of asphyxia. The pupils are, as a rule, dilated. Nausea and vomiting occasionally occur in the course of the symptoms. As a rule, the mind remains clear up to the stage of asphyxia. Socrates, poisoned by the *κώνειον* of the Athenians, which was in all probability the same as the conium under discussion, died in convulsions, but was able to converse with his friends up to near the end.

The effect of conium is well illustrated by the case of Gow, reported by Dr. Bennett (' Edin. Med. and Surg. Jour.,' 1845). After eating hemlock leaves in mistake for "greens," the patient died in a few hours with symptoms of universal paralysis, which began in the extremities and extended upwards, gradually affecting the whole muscular system, and entailing loss of voice and of articulation. Convulsive movements occurred late. Sensation and intelligence continued unaffected till death was at hand. Dr. John Harley gives a very lucid description of the symptoms produced in his own person by five drachms and a half of the *succus*. Three-quarters of an hour after taking it, he first found that he had lost the power of quick adjustment in the muscles of the eye. In another quarter of an hour this symptom had much increased, and a general muscular lethargy, with heavy eyelid and dilated pupil, supervened. In another quarter of an hour there was squeamishness and faintness, and he was cold, pale, and tottering. The nausea passed off, but the muscular weakness increased. The mind was quite intact, and the pulse, after the first excitement, was sixty-eight, and regular. There was "a direct diminution of power in all the voluntary muscles, almost amounting to paralysis," and "the greatest exertion was at one time required to elevate the eyelids." In $3\frac{3}{4}$ hours all the symptoms of poisoning had passed off. Similar symptoms occurred in two young women who took three and four drachms respectively of the succus.*

Post-mortem Appearances.—Those of asphyxia, with redness of the mucous membrane of the stomach, and congestion of the vessels of the brain.

Treatment.—The stomach should be emptied by emetics or the

* See also the interesting experiments on the effects of Conium by Dr. Burman in the ' West Riding Lunatic Asylum Med. Reports,' vol. ii. p. 1.

stomach-pump, and attention should then be directed to keep up the respiration by stimulants, and subsequently by artificial respiration.

Commencement of Symptoms.—From a few minutes to a quarter of an hour or more.

Fatal Period.—From one hour to four hours, or more.

Fatal Dose.—The smallest dose of hemlock or its preparation is not ascertained; but Burman, as the result of experiments on himself and others, concludes that one ounce of the succus is equivalent to one minim of conia. From experiments on animals, it appears that a single drop of the alkaloid will kill a cat in three minutes, and five drops a dog in one minute. The only case of poisoning by conia on record is that of Louis Berger, poisoned by her paramour, Dr. Jahn, of Dessau, in 1861. Death occurred in a few minutes from a dose of from 10 to 15 drops.

II. TOBACCO (*Nicotiana Tabacum*).

The Nicotiana tabacum, or Virginian tobacco, belongs, as do so many of our chief poisons—hyoscyamus, belladonna, stramonium—to the artificial class and order *Pentandria monogynia,* and natural order Atropaceæ (fig. 131).

Tobacco contains two active principles—a liquid volatile alkaloid, and a concrete volatile oil, known as tobacco-camphor. These are obtainable from all parts of the plant, and are contained in the infusion and decoction, and in the smoke, blended with carbonate and acetate of ammonia, and several gases. The dried leaves have a place in the British Pharmacopœia, and supply the enema tabaci—twenty grains to eight ounces. *Nicotine,* or *nicotia,* the active principle of tobacco, resembles conia as being a liquid and volatile alkaloid. When quite pure it is a colourless, oily liquid, but assumes an amber hue on exposure to air, and deepens in tint by keeping. A drop placed on a white surface of enamelled glass has a green colour, while conia is pink; and if the liquids are dropped on filtering paper, they produce greasy stains of the same colours. Nicotine has an acrid taste, and a penetrating ethereal odour. It is readily soluble in alcohol, ether, amylic alcohol, benzol, and chloroform, and also to a considerable extent in water, thus differing from conia. The aqueous solution has a distinct alkaline reaction. Like conia, it forms salts with the acids, but yields less dense fumes with the two volatile acids. The hydrochlorate differs from the same salt of conia in not crystallising at once. With oxalic acid it forms a crystalline

oxalate, distinguished from the oxalate of ammonia by being soluble in alcohol. Alkalies set free nicotine from its salts. It may thus be separated by distillation.

Nicotine is precipitated by the general reagents for alkaloids (p. 397). The differences between the reactions of nicotine and conia, with corrosive sublimate, bichloride of platinum, and carbazotic acid, have been mentioned above.

Fig. 131.

The most characteristic reaction of nicotine is that which an ethereal solution of it gives with an ethereal solution of iodine (Roussin's test). In the proportion of 1 to 100 nicotine gives with iodine solution a brownish red precipitate, which in a few minutes crystallises in long needles—1 to 2 inches long—of a ruby red colour by transmitted, and dark blue by reflected, light. When the solution is more dilute, the crystals form very slowly—in 1 to 500 after four hours (Dragendorff).

From organic mixtures nicotine is to be separated in the same way as conia.

Experiments on Animals.—Nicotine is a most active poison. A single drop is sufficient to kill a cat or rabbit in two or three minutes. In frogs it causes spasms of a peculiar character, the fore legs being drawn back and closely applied to the sides, while the thighs are abducted and the legs bent on them, so that the feet touch the pelvis (Van Praag). This is regarded as a physiological test of the alkaloid. Convulsions also occur in warm-blooded animals. Nicotine is said to act both centrally and peripherally on the nervous system in general, first exciting and then paralysing.

Locally it acts as an irritant. Dropped into the eye it produces contraction of the pupil.

The methyl derivatives of nicotine act like curara (Crum Brown and Fraser).

Symptoms.—Tobacco, or its alkaloid nicotine, in small doses causes local sensations in the mouth and fauces of warmth or burning accompanied by salivation. This is followed by unpleasant nausea and vomiting, and an excessive feeling of depression and muscular weakness. The pulse is generally quickened, but sometimes retarded. The skin becomes pale and cold, and the functions of the brain and nervous system generally, prostrated. The pulse intermits, and death takes place preceded by clonic convulsions. Occasionally, if the dose is very large, death may occur under sudden prostration and without convulsions. M. Fougnies, the victim of the Count Bocarmi, did not survive more than five minutes after nicotine was forcibly administered to him; and in a suicidal case of poisoning with nicotine which occurred in London, 1858, the sufferer was observed to stare wildly, fall down, and die without convulsions, after heaving a deep sigh.

Poisoning may result from the smoking of tobacco, as well as from its absorption in substance. Marshall Hall relates the case of a young man who smoked two pipes for his first debauch, and was seized, in consequence, with nausea, vomiting, and syncope, then with stupor and stertorous breathing, general spasms, and insensible pupil. Next day the tendency to faint continued, and in the evening the stupor, stertor, and spasms returned, but from that time he recovered steadily. Other authors have reported cases of death from excessive smoking. The effects of tobacco smoke have been generally attributed to the nicotine which it contains; but Vohl and Eulenburg attribute them rather to the final products of combustion—viz., pyridin and picolin bases. But Heubel has more recently supported the generally received notion that undecomposed nicotine is really contained in the smoke. Fatal results also sometimes follow the introduction of the infusion or smoke into the bowels; and severe effects have also followed the abuse of snuff, external application of tobacco, and sleeping surrounded by bales of the weed; or by smugglers carrying tobacco next the skin for purposes of concealment.

Fatal Period.—Nicotine may prove fatal almost immediately, or within a very few minutes. The fatal effects of tobacco are also very rapid. A case is reported of death in eighteen minutes.

Fatal Dose.—Half a drachm of tobacco has proved fatal. The fatal dose of nicotine in man has not been determined, but probably a few drops would suffice.

Post-mortem Appearances.—Not very characteristic. Turgescence of the vessels of the brain and inflammation of the stomach have been found. In the suicide by nicotine above mentioned, the appearances were general relaxation of the muscular

system, staring eyes, bloated and livid features, the vessels of the scalp and membranes of the brain, and those of the lungs, gorged with black blood, and the cavities of the heart, with the exception of the left auricle, empty. There was intense congestion of the mucous membrane of the stomach, and of the liver. The blood was black and liquid, and, in some parts, had the consistence of treacle. Nicotine was detected in the stomach, liver, and lungs, by a process similar to that of Stas.*

Treatment.—If taken in substance, and not discharged by spontaneous vomiting, emetics must be first administered. Tannin, or solution of iodine in iodide of potassium, may be given with a view to render the alkaloid insoluble. The after-treatment must consist in the free use of stimulants.

III. LOBELIA (*Lobelia Inflata, Indian Tobacco, Bladder-podded Lobelia*).

Lobelia inflata belongs to the artificial class and order *Pentandria monogynia*, and natural order *Lobeliaceæ*. It is a native of North America, and has long been used by the aborigines: it at length became a quack medicine there, and was the subject of favourable notice by a clergyman (Dr. Cutler). In the year 1829, an English physician, Dr. Reece, highly commended it as an *anti-asthmatic.*

The herb is usually imported in compressed oblong cakes of a pale green colour, weighing half a pound or a pound each; it has a nauseous odour, and acrid burning taste, closely resembling that of tobacco. The seeds, and a powder of the seeds, are sold by all the herbalists. Both have proved fatal several times in America and in England.

It owes its activity to an alkaloid, *lobeline*, which resembles conia and nicotine in being liquid, and also in many chemical characters and reactions. It gives with sulpho-molybdic acid (Fröhde's reagent) a deep violet colour, which after many hours passes into brown and then yellow (Dragendorff).

The dried herb has a place in the British Pharmacopœia, and yields two tinctures—the tinctura lobeliæ, and tinctura lobeliæ æthereæ ($2\frac{1}{2}$ ounces to the pint, and dose ten to thirty minims).

The seeds are small brown grains, and weigh 3176 to a grain. They have the size, shape, and microscopic characters depicted in 5, fig. 45, p. 394.

Lobelia is an active medicine and a potent poison. In ten-grain or scruple doses of the powdered leaves or seeds it is a

* See Taylor, 'On Poisons,' p. 750.

strong nauseating *emetic*, and has been termed the *emetic weed*. A teaspoonful, or a drachm, is a fatal dose.

Symptoms.—Speedy vomiting followed by distressing nausea, with headache, giddiness, and tremors, copious sweats, and extreme depression, are the leading symptoms. Diarrhœa and dysuria are sometimes present. Sometimes the pulse intermits, as a consequence of its depressant effect on the circulation. The fatal event is ushered in by convulsions. Employed as an enema it acts like tobacco, causing the same sickness and faintness.

Fatal Dose.—A case of poisoning by a drachm of the powdered leaves occurred in England in 1847.

Fatal Period.—In this case it was about thirty-six hours.

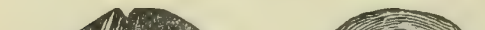
Post-mortem Appearances.—The mucous membrane of the stomach intensely inflamed, and the vessels of the brain strongly congested.

Treatment.—This consists in promoting vomiting by draughts of warm water, and tickling the throat, followed by the free use of stimulants to counteract the depressing effect of the poison.

IV. PHYSOSTIGMA VENENOSUM (*the Ordeal Bean of Calabar*).

The seed or bean of the leguminous plant Physostigma venenosum is now imported from Western Africa, and is admitted into the British Pharmacopœia, to which it supplies the extractum physostigmatis. Its chief use is in ophthalmic surgery, as an efficient means of contracting the pupil. We have become acquainted with its action as a poison through the researches of Christison, George Harley, Nunneley, and Fraser. Christison wrote on the subject as early as 1855, and Dr. Fraser published an exhaustive essay upon it in 1867.*

Fig. 132.



The bean is about the size of a pigeon's egg, and has the shape of a kidney. It has a hard, shining shell of a deep chocolate colour, and contains two white cotyledons, hollowed and marked as in the annexed illustration (fig. 132), which shows the bean of its natural size and with a vertical and trans-

* On the Physiological Action of the Calabar Bean, by Thomas R. Fraser, M.D. ('Trans. Roy. Soc. Edinb.' vol. xxiv.)

verse section. The white substance of the bean is free from bitterness, acrimony, or aroma. The absence of any property likely to attract attention or prove repulsive, is sufficiently shown by the fact that, in the summer of 1864, fifty children ate the beans at Liverpool, of whom one died. The white cotyledon assumes an orange tint when touched with nitric acid, and a yellowish brown when treated with perchloride of iron. The bean owes its activity to an alkaloidal principle to which the name of *physostigmin* or *eserin* has been given.

Properties.— Physostigmin is a colourless, resinous-like substance, which becomes brittle on drying. Vée says that it may be crystallised. It has an alkaline reaction, and is readily soluble in alcohol, ether, chloroform, and benzol, but not very soluble in water. With acids it forms salts, which are not very stable, and change colour.

Concentrated sulphuric acid dissolves it, forming a yellow solution, speedily turning olive green. Sulphuric acid and bromine water produce a reddish brown colour. The watery solution of physostigmin gives with chloride of lime a reddish colour, but is bleached by excess.

The best test for physostigmin is its effect on the pupil. A few drops of a solution of 1 in 1,000 dropped into the eye causes contraction of the pupil within a quarter of an hour.

Experiments on Animals.—Dr. Fraser describes the effect of a small and of a large dose in terms of which this is an abbreviation. *A small fatal dose*, given to one of the lower animals, first occasions a slight tremor, extending from the hind-quarters to the fore-limbs and head, and then paralysis and muscular flaccidity setting in in the same order. The rectum and bladder are then emptied. The pupils generally *contract*, the breathing becomes slow, irregular, and stertorous, and frothy mucus escapes from the mouth. Muscular twitchings occur, and often continue after respiration has ceased. Reflex action cannot be produced, the parts about the eye are insensible, and on lifting the animal by the ears the limbs hang inert, and a few gasping respirations usher in death. Immediately after death the pupils dilate. Consciousness is evidently preserved. On opening the body, the muscles are found to contract when cut, the heart acts regularly, and the intestines retain their vermicular action. The lungs are gorged with blood. *A large fatal dose* almost immediately paralyses the hind legs; the animal falls, lies flaccid, and shows muscular power only by a few twitches. The pupils contract, and the secretions of the eyes and mouth are increased. Reflex action cannot be produced, and, after a few gasps, respiration ceases. The pupils dilate after death. On

opening the body muscular twitchings occur, the heart is found distended, and retains its irritability for about ten minutes. The vermicular action of the intestines is scarcely perceptible.

The poison has proved fatal to every living creature on which it has been tried, except the Esĕrĕ moth.

The effects of doses short of poisonous are well shown in the result of experiments made by Christison on his own person. Twelve grains of the seed, chewed and swallowed, acted in twenty minutes, causing giddiness and torpor. After emptying the stomach by an emetic, the giddiness and weakness continued so as to oblige him to lie down. He was found pale and prostrate, with a weak and very irregular pulse, but the mental faculties intact. Two hours after taking the poison he felt drowsy, and for other two hours fell into a sort of conscious sleep. The symptoms then gradually went off, and next day he was quite well.* In the children who ate the beans at Liverpool, symptoms of internal irritation were present, with nausea and vomiting; some had diarrhœa, and all exhibited great weakness and prostration. In the most severe cases the pupils were contracted and the pulse weak and slow. In the fatal case (a child aged six, who had eaten six beans) there was great abdominal pain, vomiting, muscular prostration, staggering gait, and contracted pupils.

The poison causes contraction of the pupil, whether taken internally or applied externally. When the extract is applied to the eye, the effect shows itself in about ten minutes, and lasts for several hours. This contraction of the pupil is, at present, the best test for the poison. The muscular paralysis which Calabar bean produces is due to its action on the spinal cord, the excitability of which it first diminishes, and then paralyses, so that it is the direct counterpart to strychnia. Hence its successful employment in the treatment of tetanus. Ultimately it annihilates the excitability of the sensory and motor nerves. Besides its other effects, Calabar bean exerts a peculiar influence on the heart, the inhibitory apparatus of which it stimulates, tending to cause stoppage in the state of diastole. This action is counteracted by atropia.

The treatment of poisoning by the Calabar bean would consist in the prompt use of emetics, followed by the measures suited to the state of asphyxia. The elaborate experiments of Fraser on the antagonism between physostigmin and atropia ('Trans. Roy. Soc. Edin.,' 1872, xxvi.) indicate that atropia within certain limits is a complete physiological antidote to the lethal effects of Calabar bean. Along with other treatment, therefore, the subcutaneous

* 'Pharmaceutical Journal,' 1855, p. 474.

injection of small doses of atropia is indicated in any cases of poisoning with the bean which may present themselves. The Edin. Committee on the antagonism of medicines, have found hydrate of chloral an effective antidote if given immediately after an otherwise fatal dose of Calabar bean, and recommend its use accordingly.

V. CURARA (*Woorara, Woorali, Urali*).

Curara is the South American arrow poison, and is believed to be prepared from some species of strychnos. The strychnos toxifera, but, according to Preyer, the Paulinia Cururu (Sapindaceæ) may be the same. Many specimens contain also snake poison and other ingredients. It occurs as a brittle, brownish-looking extract, exhibiting a shining fracture. It is easily soluble in water. The active principle is *curarin* (Preyer), a crystallisable alkaloid soluble both in water and alcohol, slightly so in amylic alcohol and chloroform, but insoluble in ether and benzol. Owing to this peculiarity it is not separable by the usual solvents of the alkaloids in Stas's process, but remains after these have been extracted by ether and amylic alcohol.

Curarin gives with sulphuric acid and bichromate of potash the same play of colours as strychnia, but the passage of one into the other takes place much more slowly. Unlike strychnia, it gives with sulphuric acid alone, a pale violet colour, gradually turning dirty red, and ultimately a rose hue.

Symptoms.—The symptoms of poisonous doses in man have not been recorded in detail, but the phenomena which have been reported are similar to those observed in the case of the lower animals. When injected subcutaneously in frogs it speedily causes paralysis of all the voluntary muscles. The paralysis commences in the hinder extremities, and ultimately the animal lies as if dead, the heart alone continuing to beat. In larger doses the heart also becomes paralysed. In warm-blooded animals the effects are similar—paralysis of all the voluntary muscles and death by affecting the muscles of respiration. The heart is also paralysed, but later. Occasionally convulsive action of the muscles is observed before death. Lachrymation and salivation also occur among the symptoms. In animals poisoned by curara the urine becomes diabetic. The effects are due to the paralysing influence which the poison exerts on the motor nerves, first on those of voluntary motion, next those of the blood-vessels, and lastly those of the heart. The contractility of the muscles themselves remains unaffected. Analogous in their action to curara are the methyl compounds of strychnia and brucia (Brown and Fraser). The substitution of methyl causes these convulsives

to exert an action the direct opposite of that which properly belongs to them. Curara acts only by introduction into the blood either directly or by a wound. If introduced into the stomach it produces little or no effect. The explanation seems to be that excretion goes on as rapidly as absorption from the stomach, so that there is never enough in the circulation to cause poisoning. Hermann has shown that if the renal vessels are tied, poisoning results from the introduction of the substance into the stomach as surely as if it were directly introduced into the blood.

Fatal Dose.—Curara varies a good deal in strength. Preyer states that curarin is twenty times more active than ordinary curara, and that ·004 gramme will kill a frog, and ·015 gramme a rabbit or guinea-pig.

Treatment.—The treatment of poisoning by curara is by artificial respiration, which brings about recovery in animals if the dose has not been so great as to paralyse the action of the heart.

CHAPTER XIV.

ASTHENICS.

I. HYDROCYANIC ACID. II. OXALIC ACID. III. ACONITE. IV. DIGITALIS. V. VERATRUM ALBUM. VI. COLCHICUM.

THE poisons here grouped together occasion death by shock, syncope, or *asthenia*. They have all a direct action on the heart and circulation, and the first two destroy life very quickly; but their effects on the heart are not among their most marked characteristics. They are also strongly contrasted, especially in the absence of corrosive action in the one and its presence in the other. Aconite, digitalis, and veratrum are strikingly characterized by their action on the heart, and are therefore usually grouped together as cardiac poisons, to which class also belong the Antiaris toxicaria, antiar, or upas; the Dajaksh of Borneo, and the Tanghinia venenifera. Colchicum has been transferred to this group from the place which it occupied in the last edition of this work.

I. HYDROCYANIC ACID.

Hydrocyanic, or prussic acid, essential oil of bitter almonds, of which it is the active principle, and cyanide of potassium, one of its salts, as a group of poisons, ranks next in order after opium and its preparations. Prussic acid itself is the poison most frequently taken. It has been selected as an instrument of suicide by several medical men and druggists. The essential oil of bitter almonds is also often resorted to by suicides; by females nearly as often as by males.

Accidental deaths by the poisons of this group are also common, but homicidal cases very rare.

The quick and fatal effect of this poison, coupled with the frequent use of the essential oil in cookery, and of the cyanide of potassium in the arts, renders it a favourite instrument of suicide.

For medicinal purposes, the acid is formed by a complex chemical process, or by the decomposition of salts which contain it; but its elements (amygdaline and emulsine) also exist in the leaves, flowers, and fruit-kernels of many plants belonging to the natural order Rosaceæ. The bitter almond, cherry-laurel, peach, cluster cherry, and mountain ash ; the kernels of peaches, plums, cherries, and the pips of apples contain the acid ; which may be distilled from them, mixed with an essential oil. The cherry-laurel water was given as a poison in the well-known case of Sir Theodosius Boughton; and a bitter almond water improperly kept in the shops of very variable strength, and incautiously prescribed, has proved fatal.

Hydrocyanic acid exists in two forms : anhydrous, and diluted with water. Both are colourless. The first has an acrid pungent taste, and a peculiar odour; is highly inflammable; boils at 80°, freezes at 5°, and at common temperatures by its own evaporation. Exposure to light soon decomposes and turns it brown. The dilute acid of the shops is commonly used as a poison. The pure acid has no medico-legal interest.

Dilute Hydrocyanic Acid.

Properties.—The dilute has the same appearance, odour, and taste as the strong acid, but if kept from the light is less apt to decompose. It is volatile, and loses strength by exposure, and it varies with the mode of preparation. The strength of the acid differs with its age, so that it has been found to vary from 1·3 to 6·5 per cent. (Taylor.) The acid that results from the decomposition of a solution of ferrocyanide of potassium by sulphuric acid is the most stable, and may be kept for years exposed to diffused light without change.

The strength of the acid in use in different countries, varies greatly : that of the British Pharmacopœia should contain about 2, that of Vauquelin 3·3, and that of Scheele 5 per cent.

Among the properties of prussic acid just described, there is one so characteristic and delicate as to constitute a test, namely—

The Odour.—This is perceptible even in weak specimens ; has the advantage of not demanding chemical knowledge or skill in the observer ; and when perceived by several persons is conclusive. During life the odour is perceptible in the breath ; after death, at the mouth, in the contents of the stomach, and in the tissues, and it is diffused through the air. But in patients under treatment, it may be disguised, as in a case in which assafœtida was

used in an injection (G.); and in the dead body, though generally recognisable soon after death, it may disappear in less than twenty-four hours. In the case of Sarah Hart, the victim of Tawell, it was perceived by two only out of five witnesses, eighteen hours after death; in one reported by Mr. Newham, of Bury St. Edmunds, after eleven hours in the stomach, heart, and brain; and in an interesting case of double suicide (that of C. W. Duckett and Elizabeth Williams, reported by Dr. Letheby), about the mouth twelve hours, and, according to Mr. G. Davies, seventeen or eighteen hours after death.

Tests.—Besides the odour, there are three recognised tests, equally applicable to the acid in solution and in vapour. These may be designated as the silver, iron, and sulphur tests.

1. *Silver Test.*—A solution of nitrate of silver gives with liquids containing hydrocyanic acid a white clotted precipitate, insoluble in nitric acid at common temperatures, but soluble at a boiling heat. If the precipitated cyanide, washed and dried, is introduced into a tube closed at one end, and drawn out at the other into a fine point, and the precipitate is heated by the flame of a spirit-lamp, cyanogen gas is driven off, which, on being lighted, burns with a highly characteristic crimson flame, surrounded by a blue halo.

2. *Iron Test.*—Add to the suspected liquid a little liquor potassæ, then a few drops of a solution of the mixed protosulphate and persulphate of iron. A brownish-green precipitate is thrown down, which, on adding a little dilute hydrochloric acid, becomes Prussian blue.

3. *Sulphur Test.* (Liebig's Test.)—To the liquid containing the acid add a few drops of sulphide of ammonium; heat the liquid gently till it becomes pure white or colourless; then evaporate slowly. A white amorphous sulphocyanide of ammonium remains, which assumes an intense cherry-red colour when touched with a solution of perchloride of iron: a colour which is discharged by corrosive sublimate, and so distinguished from a similar colour produced with meconic acid.

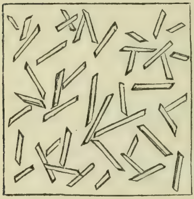
When these tests are applied to detect the acid by its *vapour*, the following method of procedure is to be observed:—

Place the fluid or substance yielding the vapour in a watch-glass; moisten a large flat disk of glass with the test; invert it over the watch-glass, and allow it to remain till a distinct reaction is perceptible through the disk.

In the case of the *silver test*, moisten the glass disk with a weak freshly made solution of nitrate of silver (gr. 1 to f℥j) and expose it to the vapour. The spot soon becomes opalescent,

and when dry, leaves a white stain, which, examined by the microscope, is found to consist of distinct prisms, or long plates, more or less thickly interlaced (fig. 133). Compare the stain with that left by a drop of the silver solution. It is faintly white, and has no distinct crystalline form.

Fig. 133.



In the case of the *iron test* moisten the glass disk with a drop of liquor potassæ, and after due exposure add a drop of the fresh solution of the mixed sulphates of iron. Develop the Prussian blue by dilute hydrochloric acid. Compare with the Prussian blue the brown oxide of iron thrown down by liquor potassæ from the test liquid.

In the case of the *sulphur test,* moisten the glass disk with sulphide of ammonium, allow the white stain of cyanide of ammonium to dry, and test with a drop of perchloride of iron solution, so weak as to be nearly colourless. Compare the cherry red of the sulpho-cyanide with the yellow of the dry spot of the perchloride. As the liquid in the watch-glass absorbs some of the vapour of the sulphide of ammonium, and turns white, it may be allowed to dry, and be tested with the perchloride of iron.

Of these tests of prussic acid in vapour, the silver test is the most satisfactory. A single apple-pip bruised and moistened with distilled water, and placed in a watch-glass, yielded as many as twenty-two distinct reactions. The solution of nitrate of silver was rendered opalescent in every instance, and the dried stain contained microscopic crystals of the cyanide. The other tests, in experiments made under exactly similar circumstances, gave less satisfactory results. Three apple-pips were bruised, moistened, and placed in three watch-glasses; and the three tests were used in the way already described for ten successive exposures of five minutes each. The nitrate of silver acted characteristically in all; the Prussian blue test succeeded in three; and Liebig's sulphur test in one. But the liquid in the watch-glass was whitened by the sulphide of ammonium, and, when dry, yielded a white stain, having a characteristic reaction with the per-salt of iron (G.).

Hydrocyanic Acid in Organic Mixtures.

The acid being highly volatile, the examination of all organic liquids and substances supposed to contain it should be made without delay.

For the detection of hydrocyanic acid in such organic matters and liquids we resort to a process of distillation. But, previous to doing so, we may apply the tests to the vapour given off. The process of distillation is conducted as follows:—

The filtered liquid, if alkaline, is neutralized by sulphuric acid, which will fix any ammonia that may have been generated by putrefaction. It is then to be distilled from a water-bath, at about 150° Fahr., till about an eighth part has passed over. This fluid may then be tested by the reagents just described.

It has been objected to this, and every other process in which heat is employed, that hydrocyanic acid may be formed during distillation by the decomposition of animal matter. This is a mere conjecture, unsupported by experiment. It has also been objected that the acid may be formed in the course of the putrefaction and decay of various animal and vegetable matters, such as cheese and the ergot of rye.

These objections are futile in all those cases in which persons are found dying or dead with the odour of prussic acid strong upon them; and in many cases they are effectually removed by analysing the secretions of the body itself, such as the serum of the brain. In a case which I saw during my pupilage, hydrocyanic acid was readily detected by its odour in all parts of the body, and was found in the brain by Mr. Everett (G.).

Quantitative Analysis.—Use for this purpose the precipitated cyanide of silver; 100 grains correspond to 20·33 of the pure anhydrous acid.

EXPERIMENTS ON ANIMALS.

Hydrocyanic acid in all its forms is a most energetic poison. Animals made to breathe air saturated with the vapour of the anhydrous acid, die instantaneously (Pereira), or in from one to ten seconds (M. Robert). The fluid anhydrous acid acts nearly as rapidly. A single drop put into the throat of a dog killed it after two or three deep hurried respirations; it acted almost as quickly when dropped under the eyelid; and when injected into the jugular vein, the animal fell dead at the very instant as if struck with a cannon ball, or with lightning (Magendie). A single drop in the mouth of a rabbit began to act in sixty-three seconds, and killed it in eighty-three; three drops began to act on a cat in ten seconds, and on another in five, killing the first in thirty seconds, and the second in forty; four drops began to act on a rabbit in twenty, and killed it in thirty seconds; and a quantity equivalent to an ounce and a half of medicinal acid, began to act on a rabbit directly it was poured into its mouth,

and killed it outright in ten seconds at the farthest. Three drops projected into the eye, acted on a cat in twenty seconds, and killed it in twenty more, and the same quantity dropped on a fresh wound in the loins, acted in forty-five seconds, and proved fatal in one hundred and five. In the slower cases, there were violent fits of tetanus; but in the very rapid cases the animals died just as the fit began to show itself, with retraction of the head. In rabbits the spine was bent back, in cats it was curved forwards (Christison).

The concentrated acid, then, according to its quantity and mode of administration, may begin to act on the animals usually submitted to experiment instantaneously, or in from five to sixty-three seconds, and may kill in from ten to one hundred and five. When dropped into the mouth it may begin to act in from five to ten, and prove fatal in from thirty to forty, seconds.

The effects of the dilute acid on animals have been reported by several observers. Mr. Nunneley, of Leeds, who made a very large and carefully conducted series of experiments, mostly on dogs, shows that a large dose of the dilute acid kills as quickly as the concentrated acid; and that moderate dilution not only does not impair, but even somewhat enhances its effects. Large doses of the dilute acid destroy life in from two to fifteen minutes; but life may be prolonged, after a fatal dose, for hours or even days. A dog poisoned by Coullon died after nineteen days of suffering.

When the dose is short of a fatal one, the animal is seized in one or two minutes with giddiness, weakness, salivation, and protrusion of the tongue, hurried, panting respiration, livid face, and protrusion of the eyes, with convulsions or tetanic spasms, passing into paralysis and insensibility. After lying in this state some time, sensibility and power of motion are gradually restored, with slight convulsions and gasping respiration, and sometimes with strong convulsions and loud howlings. The animal then falls into a sleep, sometimes so profound as to resemble the effects of opium, and wakes up recovered but feeble. The breath of the animal has the odour of the poison. In cold-blooded animals, such as frogs, the poison kills without causing convulsions.

Several questions of obvious medico-legal importance relating to the symptoms of poisoning by prussic acid have been illustrated by experiments on animals.

Convulsions.—The question whether convulsions are among the common symptoms of poisoning by prussic acid has been answered in the affirmative. They are generally present; but frequent exceptions to the rule are recorded by almost all who have experimented largely on animals.

The Shriek or Cry.—This too is a common, but not constant, symptom. It is described by Mr. Nunneley as "a peculiar cry, indicative of severe distress, different from anything heard in any other state," and "characteristic of the poison." In his numerous experiments it was present in only half the dogs.

Expulsion of Fæces and Urine.—The fæces alone were passed in about a tenth of the cases; in another tenth both fæces and urine; in a far larger number the urine alone; and in about two-fifths of the whole neither fæces nor urine (Nunneley).

Acts of Volition.—Such acts are often performed before the poisonous effects show themselves. One dog, after taking the poison, "went down three or four steps of some stairs, saw the door at the bottom was closed, and came back again;" and another "went down, came up, and then went down again the whole flight of a steep winding staircase;" and a third after jumping over one of the dogs, leaped completely across the open top of the staircase (Nunneley).

The *Post-mortem Appearances* in the animals submitted to experiment are not well marked. The brain has generally a natural appearance, though its vessels have been found turgid, and in one instance (in the horse) there was extravasation of blood between its external membranes. The heart and great vessels differ in their state and contents, according as death occurs quickly or slowly. In cases of sudden death, the left side of the heart is, in almost every case, perfectly empty and rigidly contracted, while the right contains blood, sometimes in large quantity. In chronic cases, both sides of the heart are distended with black blood (Nunneley). Sometimes the blood is florid; but usually it has the dark colour of asphyxia. In frogs poisoned with prussic acid, the heart is found dilated, and filled with bright red blood. This colour of the blood is attributable to an alteration in the form of the corpuscles, so that they reflect light more readily. Hoppe-Seyler and Preyer, state that prussic acid forms a crystalline compound with the blood colouring matter, but this cannot be detected in the blood of animals poisoned with it. Schönbein also states that prussic acid destroys the ozonising property of the blood corpuscles. According to Magendie, the pure acid so completely destroys the irritability of the heart and voluntary muscles, that they are insensible even to the stimulus of galvanism. But "in eight experiments on cats and rabbits with the pure acid, the heart contracted spontaneously, as well as under stimuli, for some time after death, except in the instance of the rabbit killed with twenty-five grains, and one of the cats killed by three drops applied to the tongue. In the last two the

pulsation of the heart ceased with short fits of tetanus which preceded death; and in the rabbit, whose chest was laid open instantly after death, the heart was gorged, and its irritability utterly extinct" (Christison). The lungs are sometimes empty, but more frequently gorged with blood. The membrane to which the acid is applied is usually congested. The corpse is generally very rigid.

The action of prussic acid is not yet in all respects satisfactorily determined. Preyer * ascribes the chief symptoms to irritation of the vagus, both pulmonary and cardiac, and regards the convulsions as essentially those of asphyxia, but this is disputed on good grounds by Böhm and others. Though the affection of the respiratory centres is a prominent feature, the convulsions cannot be explained by this alone. Prussic acid is a universal poison both to plants and to the animal tissues and organs.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms of poisoning by prussic acid in the human subject vary, as experiments on animals would lead us to expect, with the dose, and with the age, strength, and state of the patient. When the dose is large, the symptoms begin in a few seconds or minutes. There is probably, in all cases, a short interval of consciousness, and then a sudden access of giddiness, rapidly followed by insensibility, deep catching respiration, and speedy death. When the case is prolonged beyond a few seconds or minutes, other symptoms are superadded.

The symptoms of the fatal cases and those of greatest severity are:—insensibility, laboured respiration, with short inspiration and prolonged expiration, rattling in the throat and frothing at the mouth. The jaws are clenched, and there are spasms of the muscles of the face and extremities, sometimes general convulsions and expulsion of the urine and fæces. The skin is cold and livid, the eyeballs prominent, the pupils dilated and insensible, reflex excitability is abolished, and the pulse becomes imperceptible.

In the less rapidly fatal cases, there is a sense of constriction of the throat, salivation, giddiness, confusion of ideas, a sense of oppression, and præcordial anxiety. Insensibility comes on with laboured respiration and the other symptoms mentioned, convulsions being common. In cases of recovery, vomiting is not unfrequently observed.

* 'Die Blausäure' 1870.

The short interval of consciousness which, as just stated, probably occurs in all cases, is sometimes filled in by voluntary acts. But a few persons after swallowing large doses have staggered a few steps, fallen without a groan apparently lifeless, and died after a few convulsive expirations, in less than four minutes after swallowing the poison; others have uttered expressions of fear, and then fallen as if struck by lightning. In many cases they have been heard to fall without uttering any sound.

The Post-mortem Appearances are not characteristic. Sometimes the face is pale, the eyes brilliant, and the jaws clenched, with froth at the mouth; or the face and skin show well-marked lividity. Internally the appearances are such as are usually found in asphyxia, a reddened or congested state of the mucous membrane having been frequently noted.

The stomach and every part of the body exhale the odour of prussic acid; but not in all cases. It may be expected to be absent when the patient lives long enough to exhale it freely from the lungs, or where the body has been for some time placed under circumstances favourable to evaporation. It has been recognised in the stomach, and not in other parts; and in other parts when there was no trace of it in the stomach. The odour is most conclusive when perceived in the blood or limbs; for it is said occasionally to exist in the stomach and intestines, and in the brain, when no prussic acid has been taken.

Treatment (*Antidotes*).—Chlorine and the mixed oxides of iron act as antidotes to prussic acid, the one by withdrawing the hydrogen of the poison, the other by forming with it the insoluble Prussian blue. But there are few cases in the human subject in which an antidote can be applied, and none in which to prepare an antidote would not be to lose valuable time. In the great majority of cases the medical man is called to a suicide already dead, or *in articulo mortis;* and when the patient is still alive, the jaw is so firmly closed as to render the introduction of an antidote very difficult, if not impossible.

The first step to be taken is to administer the *cold affusion* as a shock, by water dashed into the face, or freely poured on the head and back. As soon as the patient is roused, though still insensible, and perhaps in convulsions, he must be undressed, wiped dry, and put to bed. An attempt may now be made to pass a feather to the back of the throat to promote vomiting, and a sponge or rag sprinkled with disinfecting fluid may be held to the nostrils, the surface being kept warm by hot cloths or flannels, and by friction with the hand or flesh-brush. As soon as the jaws can be opened, and the patient be made to swallow, an

emetic of sulphate of zinc, of mustard, or of common salt, should be given ; or the stomach-pump may be employed.*

Fatal Dose.—This may be stated for the adult at somewhat less than a grain of the pure acid, or about 45 minims of the acid of the British Pharmacopœia. Very severe symptoms have been caused by about half a drachm of this acid, but recovery has taken place from doses of seventy or eighty drops.

Commencement of the Symptoms.—There are no cases on record of that instantaneous action in the human subject which has been noted in experiments on animals. But when the dose is large the symptoms set in very soon, and death quickly follows. In a case reported by Hufeland, a quantity equivalent to forty grains of the pure acid was taken. The man was seen to swallow the poison, was observed to stagger a few steps, and then to sink without a groan, apparently lifeless. But after smaller fatal doses, or doses productive of severe effects, a short interval elapses between the taking of the poison and the loss of sense and power. The voluntary acts that can be performed in this interval will be presently ascertained by an appeal to cases.

Fatal Period.—After a large dose, death takes place in from two to five minutes. But patients may survive twenty minutes, half an hour, three-quarters of an hour, or an hour ; and may continue in imminent danger for several hours, and yet recover.

Voluntary Acts.—The question whether, after taking a large dose of prussic acid, the patient retains his consciousness for a time, so as to be able to perform certain voluntary acts, is an important one. In favour of the retention of consciousness I have the distinct statement of the patient whose case will be presently cited (G.); and that many voluntary acts may be performed in this conscious interval is proved by several recorded cases. The medico-legal import of the question will be understood from the following case :—

An apothecary's maid-servant at Leicester, pregnant by Freeman, her master's apprentice, was found dead in bed, poisoned with prussic acid. The apprentice was suspected of having been accessory to her death ; but, as it was proved that the deceased had made preparations for effecting a miscarriage, she might have taken the poison of her own accord. The question of suicide or homicide could be answered only by referring to the condition in which the body was found. It appeared from the evidence that it lay at full length on the bed, with the head turned a

* Preyer recommends the subcutaneous injection of atropia as a physiological antidote to the action of hydrocyanic acid on the vagus.

little on one side, the arms crossed over the trunk, and the bed-clothes pulled smoothly up to the chin; under the clothes, on her right side, lay a corked phial, wrapped in paper, and containing three drachms and a half of the poison. The leather and string which had fastened the cork were found in the chamber vessel.* It was probable, therefore, that four and a half drachms of the poison had been swallowed; and the question arose, could the girl, after taking this quantity of the poison, have corked the bottle, wrapped it up, and adjusted the bed-clothes.

This question can be answered only by an appeal to fatal suicidal cases in which similar acts of volition have been performed; or by comparing the time which such acts occupy with ascertained intervals of consciousness. The experiments on animals performed by some of the medical witnesses examined in this case, though useful as illustrations, are quite inconclusive.

The following facts may be cited in illustration:—An apothecary's assistant in Germany took four ounces of the acid of the Bavarian Pharmacopœia, and was found dead in bed, with an empty two-ounce phial on each side of the bed, the bed-covering pulled up as high as the breast, the right arm extended beneath it, and the left arm bent at the elbow. In a suicidal case reported by Mr. Newham, the bed-clothes were smoothly drawn up to the shoulders; and on a chair close to the back of the bed was a phial with the cork in it. A case of the same kind was communicated to Dr. Taylor by a pupil. A man found dead on the seat of a water-closet, had the bottle from which the poison was taken corked in his pocket. In the case of the double suicide reported by Dr. Letheby, the bodies were found in positions which implied a succession of slight voluntary movements.

These facts prove the possibility of slight voluntary efforts being made after a large dose of prussic acid; and they justify, as far as this question is concerned, the verdict of acquittal pronounced in favour of Freeman.

But the voluntary acts that may be done after fatal or highly dangerous doses of this poison go much beyond those inferred from the position of the bodies in these instances. In the suicidal case presently to be more minutely described, as one of recovery after six hours of imminent danger, the lad took a large dose of the poison in bed; but he got out of bed, walked round the foot of it to a chest of drawers distant two or three yards, placed the stopper firmly in the phial, and returned to the side of the bed from which he fell senseless.

* See this case very fully reported, 'Medical Gazette,' vol. viii. p. 759.

In another class of cases the suicide, besides other movements implying volition, has been able to cry for help and even to converse.

An apothecary's apprentice sent from the shop to the cellar had only been a few minutes away when he was heard to cry, in great alarm, "Hartshorn! hartshorn!" On rushing down stairs, his companions found him lying on the lower step, grasping the rail; and he had scarcely time to mutter, "Prussic acid!" when he died, not more than five minutes after leaving the shop. He had taken a drachm of the Bavarian acid, had tried to get at the ammonia, but had not strength to uncover the bottle.

In two cases reported by Mr. Nunneley, the patients not only moved about, but spoke and answered questions, after taking, the one a fatal, the other a large dose of the poison. The subject of the first case answered a question some minutes after he had taken the poison, and the man who recovered retained the use of speech till the jaws gradually closed.

A hypochondriac gentleman, having locked himself in his room, took seven drachms of prussic acid of the estimated strength of three per cent., but after about a minute he unlocked the door, and cried out, "Come to me quick, I am dying." A servant immediately entered the room, and found him lying on his back on the sofa, with his legs crossed, insensible, and snoring. Dr. Sewell arrived in twenty minutes. He was then dead, and presented the appearance of profound slumber; legs crossed, arms by his sides, and eyelids firmly closed.*

The effects of prussic acid taken in a large, but not fatal dose, will be seen by the two cases which follow. The first is described in the 'Revue Médicale,' for February, 1845, the second came under my own observation in the previous year (G.).

Dr. B——, a physician at Rennes, having taken, without inconvenience, a teaspoonful of prussic acid, prepared by himself, in the morning, and a second, prepared after Scheele's method, after dinner, took a third teaspoonful of a preparation purchased of M. Vauquelin, and after an interval of a few seconds, another. This new preparation tasted a little stronger, and Dr. B—— remarked that "it had not hurt him;" but, on walking out of the shop, he felt an alarming disturbance in his head, and, on returning, uttered a few expressions of fear, and fell down as if struck by lightning. The teeth were firmly closed, there was continually-increasing dyspnœa, with noisy rattling respiration,

* This case is reported by Dr. Sewell, of Montreal. For full details of some of the cases just cited, and for additional cases, refer to Ranking's 'Half-yearly Abstract of the Medical Sciences,' vol. ii. p. 399.

cold extremities, distortion of the mouth, redness and swelling of the face and neck, fixed and dilated pupil, and a pulse imperceptible in the left, and very small in the right, arm. The trismus became more marked, a short and violent convulsion ensued, and the abdomen, especially about the epigastrium, became rapidly distended. Attempts were now made to rouse him by stimulant frictions and applications; and on tickling the throat with a feather, some dark-coloured mucus was discharged. After remaining in this state for two hours and a half he showed signs of returning consciousness, and recognised those around him. The mental faculties were gradually restored, but considerable difficulty of breathing and very distinct rattle remained, with occasional expectoration of yellowish black mucus. During the whole of this time the breath smelt strongly of prussic acid. Dr. B—— was thirteen days before he could go out to see his patients, during which time the dyspnœa was frequently distressing, particularly when he turned in bed, and when he woke in the morning. At last he quite recovered. During the first four days very little urine was passed.

In the winter of 1844, I was called up at night to see a young gentleman who had swallowed prussic acid. The facts of the case, as detailed by himself and his relatives, are as follows :—

He is the son of a medical man, is about nineteen years of age, and studying the law. His disposition is naturally cheerful; his habits are temperate and industrious; he has met with no disappointment; and, till now, had never contemplated suicide. On the afternoon of the day on which he swallowed the poison he dined in the Hall of one of the Inns of Court, and drank much more wine than he was in the habit of taking. When he got home he was observed to be somewhat the worse for liquor, and before going to bed went into the surgery, from which he took a stoppered bottle, believed to have contained from one to two drachms of prussic acid of Pharmacopœial strength, but according to his own statement, about a mouthful. Soon after he had gone to bed the family was startled by a noise in his room as of a heavy body falling, and a relative passing at the time, was alarmed by a loud gurgling noise. His father was almost immediately on the spot, and seeing the bottle on the drawers, dashed several buckets of water over the face and chest. This roused him. He was then taken into an adjoining room, and put to bed, the treatment consisting in holding ammonia to the nostrils, and applying heat to the spine and feet. An injection was also given, containing tincture of assafœtida.

When I reached the house I found him in the following state,

in which he had continued without alteration for three hours :—He lay on his back, drawing in his breath with great effort, and a loud gasping sound, with a distinct mucous râle. The pulse was upwards of 140 in the minute, and the respiration 36. The surface very cold; the countenance of a dull leaden hue; the lips blue; the pupil extremely dilated; and the jaws rigid, in which state they had remained for the whole period, so that it had been impossible to administer any antidote.

The treatment from this time consisted in ammonia to the nostrils, assiduous frictions with the flesh-brush, and the application of heat to the surface by means of warm flannels. At the expiration of about five hours there was some effort to vomit, encouraged by tickling the throat, and some bloody mucus was wiped from the mouth. Soon afterwards he could be made to swallow, when some warm brandy and water and strong coffee were given him. At this time, too, he could answer in monosyllables, and raise himself on his elbows: was perfectly sensible, but looked bewildered. At the end of about six hours he was sufficiently recovered to answer questions, move himself about, and call for lemonade, which he drank freely. The mucous râle had disappeared, the respiration and pulse were still frequent, the pupil was restored to nearly its usual size, and the skin was warm. Being disposed to be quiet, and seeming out of danger, he was left to himself. After a time he complained of fulness at the stomach, and asked for an emetic, which brought off a large quantity of undigested food.

About fourteen hours after taking the poison I found him quite well, though weak. He gave the following distinct account of the attempt of the night before :—He was suddenly tempted, as he said, by the devil to take prussic acid, under a confused idea that it would not hurt him. He swallowed a mouthful of the acid from the bottle, in bed. He then got out of bed, walked round the foot of it to a chest of drawers standing within a few yards of the bedside, placed the stopper so firmly in the bottle that it could not be removed, and then walked back to bed, intending to get in again, but sat down on it, and then lost all consciousness. During all this time he had no giddiness, nor unpleasant sensation of any kind, no more than if he had taken so much water. He also assured me, and his manner made me quite confident that he spoke the truth, that the idea of suicide had never before entered his head. The father of the lad afterwards told me that the fæces, and, as he believes, the urine too, were expelled as the first effect of the poison.

The bottle which had contained the poison was found quite empty,

so that it was not possible to ascertain the strength of the preparation. From the statement of the father and apprentice, that the bottle contained one or two drachms, and that of the lad himself, that he had swallowed a mouthful, it is highly probable that the dose taken would have proved fatal had it not been for the prompt application of the cold affusion, the continued use of ammonia, and the assiduous application of warmth and friction to the surface—remedies obviously indicated by the extreme coldness of the skin, the blueness of the hands and face, the labouring respiration, and the abundant collection of mucus in the air-passages.

This case is a good illustration of the interval of perfect consciousness and complete command of the muscles which may intervene between the swallowing of a large dose of prussic acid and the development of its characteristic effects; and it is a very striking example of a class of cases of suicide in which the impulse to the commission of the act precedes the act itself by a very short interval, and springs up during a temporary excitement of the mind.

Three medico-legal questions which have been raised in cases of poisoning by prussic acid have still to be considered. To two of these some importance was attached in the case of Sarah Hart, the victim of Tawell. 1. In poisoning by prussic acid, is there any death-cry or scream which would serve to announce the action of the poison? 2. Are convulsions of common or of universal occurrence? 3. Is prussic acid a cumulative poison? 1. In answer to the first question it may be stated that a patient who is conscious of having swallowed the poison may call out for assistance: but the plaintive cry, or scream, sometimes heard in animals, has not yet been recorded in any case of poisoning in man. 2. It is probable that convulsions are not of more frequent occurrence in poisoning by prussic acid than in other forms of sudden death. The expulsion of the urine and fæces, observed in certain cases, was probably accompanied by short convulsions, and in some cases (as in one reported by Mr. Hicks) there have been efforts expressive of intense anxiety and urgent want of breath; but the deliberate movements of the patient, and the calm and easy attitude of the dead body in almost every instance, show that convulsions are either absent altogether or short and transient. 3. The question, Is prussic acid a cumulative poison? may be raised when a patient dies whiletaking a series of medicinal doses of the acid at intervals of a few hours. It is reasonable to suppose that the previous doses have not spent their force on the body, and that the addition of the last dose determines the fatal result. In the case of so volatile a poison, and one so

readily eliminated, it seems highly improbable that a medicinal dose (generally a small fraction of the smallest fatal one), or even a series of such doses would leave such a residual effect as to prove fatal on the addition of another dose : but doses that exceed the proper medicinal limit may happen to prove fatal though similar previous ones have appeared to be harmless, in consequence of a change in the state of the body itself; for there is no doubt that the line which divides a harmless from a fatal dose is not very wide. Fortunately this question, so difficult of solution, is not one of great practical importance.

POISONING BY THE CYANIDES.

The cyanides of potassium and of mercury have destroyed life, the latter with symptoms allied to those of poisoning by corrosive sublimate (see p. 489), the former with symptoms of poisoning by the acid itself.

Cyanide of Potassium.—This substance is now largely used in the arts, both in electrotyping and in photography. It is used to remove stains of nitrate of silver from the hands, and to clean tarnished metal and gold and silver lace.

Properties.—This salt is sold as a deliquescent white crystal or crystalline mass, having a strong odour of prussic acid, and a characteristic cold, bitter, and pungent taste. It is very soluble in water ; and the solution has a strong alkaline reaction.

Tests :—a. On adding an acid, the vapour of prussic acid is given off, which may be identified by its odour, and by the tests described at p. 593. *b.* It yields with a solution of nitrate of silver the white cyanide. *c.* Chloride of platinum throws down the base. *d.* The liquid tests produce with the solution the reactions described at p. 593 ; but as the solution already contains potash, the addition of liquor potassæ is not needed.

In *organic liquids* the poison may be detected by neutralizing the base with sulphuric acid, and distilling over the prussic acid.

Symptoms.—This substance acts nearly with the rapidity and violence of prussic acid itself, and gives rise to the same symptoms.

Fatal Dose.—Less than five grains. As the cyanide contains nearly 40 per cent. of the anhydrous acid, it is probable that about two and a half grains would destroy life.

Post-mortem Appearances.—Those of poisoning by prussic acid.

Treatment.—That of poisoning by prussic acid itself. As the cyanide is a strong irritant, it should be used with caution, whether to remove stains, or for manufacturing purposes.

VEGETABLE SUBSTANCES AND PRODUCTS CONTAINING, OR YIELDING, HYDROCYANIC ACID.

The leaves, seeds, or roots of several plants contain prussic acid, or yield it when bruised and moistened. It is found in the bitter almond, the kernels of the cherry, plum, and peach, and the pips of the apple. The poison is extracted from the leaves of the cherry laurel by distillation, and the plant which yields tapioca (the *Iatropha manihot*, or cassava) contains it in the juice of the root. The bitter almond, the oil and water obtained from it, and the water distilled from the cherry laurel, deserve special notice.

The Bitter Almond is distinguished, as its name implies, by its bitter taste. It forms with water a white emulsion, in which the essential oil blended with prussic acid is rapidly developed by the mutual action of two of its constitutents, *emulsine* and *amygdaline*. The vapour from the emulsion acts characteristically with the tests for prussic acid. As the same change takes place in the stomach, bitter almonds cannot be safely eaten nor the *bitter almond cake*, which remains after the expression of the fixed oil. This oil, its alcoholic solution (almond flavouring), and bitter almond water, are active poisons, and have proved fatal. Of these three preparations the first is by far the most important, as it is a very active, and a very favourite, poison.

Essence or *Oil of Bitter Almonds*.—This is the product of the distillation of the pulp or emulsion of the bitter almond. It contains, in addition to hydrocyanic acid, hydride of benzole, benzoin, and benzoic acid. The acid, to which it chiefly owes its poisonous properties, may be separated from it, and the essence thus purified, and rendered comparatively harmless, is sold for culinary purposes. The essence, or oil, previous to this separation, contains from $8\frac{1}{2}$ to $14\frac{1}{2}$ per cent. of the anhydrous acid. It is, therefore, from four to seven times as strong as the acid of the Pharmacopœia. A liquid variously known as *almond flavour*, spirit of almonds, or essence of peach kernels, consists of the oil dissolved in seven or eight times its quantity of spirit.

Properties.—Ordinary specimens of the oil have the colour of amber, a peculiar, pungent odour, due in part to the prussic acid which it contains, and a bitter, aromatic taste. It is heavier than water, which dissolves only a small fraction of it; but it is soluble in alcohol and ether. It produces a greasy stain on paper, and has a slight acid reaction. Strong sulphuric acid reddens it.

Tests.—Those of hydrocyanic acid. Pour drops of the oil into a series of watch-glasses, add a few drops of distilled water,

and invert over them disks of glass moistened with the several tests (p. 593). Or, place a few drops of the oil in a test-tube, add a drachm of distilled water, mix well by shaking; pour the mixture on a wet filter, and test the liquid that passes through for dilute hydrocyanic acid.

Symptoms.—Those of poisoning by hydrocyanic acid (p. 598); but the symptoms begin later, and last longer; present similar variety; and similar acts of volition occupy the interval between swallowing the poison and the commencement of the symptoms.

Post-mortem Appearances.—Those of poisoning by prussic acid (p. 599), the odour of the oil taking the place of that of the acid.

Treatment.—That of poisoning by hydrocyanic acid (p. 599).

Fatal Dose.—About twenty drops. As strong specimens of the oil have from four to seven times the strength of the acid of the Pharmacopœia, and a less quantity of the acid than fifty minims has proved fatal, it is probable that ten or twelve drops might kill an adult.

Duration.—From a few minutes to half an hour. It may destroy life as speedily as prussic acid itself.

Bitter Almond Water.—This is distilled from the cake left after expressing the fixed oil. It is found in the shops of variable strength, from a quarter per cent. to one per cent., and should never be used as a medicine. It owes its poisonous property to the prussic acid it contains; and responds to the tests for that poison (p. 593). The symptoms, post-mortem appearances, and treatment are those of poisoning by the acid (p. 598).

Laurel Water.—The leaves of the cherry laurel (*Prunus laurocerasus*), fig. 134, yield both a distilled water and an essential oil, which have the same properties as the water and oil of bitter almonds, and were formerly employed for the same purposes. The quantity of prussic acid in the water is about a quarter, and in the oil three and a quarter, per cent. Other portions of the plant also yield the poison; but it is not contained in the pulp of the fruit. The cherry-laurel water has more than once proved fatal; but the case which possesses the greatest interest is that of Sir Theodosius Boughton, poisoned by Captain Donellan in 1781.

Sir Theodosius Boughton, a healthy young man twenty years old, was in the habit of taking a laxative draught from the hands of his mother. On the morning of his death she observed, while giving him his draught, that it had a strong smell of bitter almonds. "Two minutes after he took it she observed a rattling or gurgling in his stomach; in ten minntes more he seemed inclined to doze, and in five minutes afterwards she found him

quite insensible, with the eyes fixed upwards, the teeth locked, froth running out of his mouth, and a great heaving at his stomach, and gurgling in his throat. He died within half an hour after swallowing the draught." The body was carelessly inspected ten days after death, but the post-mortem appearances threw no light on the cause of death. The odour of the draught, the rapid occurrence of symptoms so closely resembling those present in recorded cases of poisoning by prussic acid, and the speedy death of the sufferer, at an age when apoplexy is so rare, combine to leave no reasonable doubt of the real cause of death.

Fig. 134.

II. OXALIC ACID (*Acid of Sugar*).

Oxalic acid, under the name of acid of sugar, is largely used by book-binders, shoemakers, and workers in leather; by straw-bonnet makers and workers in straw; and by workers in brass; also to take ink stains out of linen. It is sold both by druggists and by persons who supply the trades using it. Its cheapness (2*d.* per ounce), common employment, and known activity, commend it to the suicide; its resemblance to Epsom salts leads to accidents; but its sharp, sour taste unfits it for the purpose of the murderer, unless mixed with some strongly-flavoured liquor, such as gin, brandy, rum, porter, or strong tea or coffee.

Oxalic acid takes the sixth place among the poisons. It accounts for about 12 deaths per annum, or about 1 in 20 of the ascertained poisons. Of 12 deaths, about 4 occur in men and 8 in women, and the majority in both sexes are suicidal.

Oxalic acid may have to be examined in *substance*, in *solution*, and in *organic mixtures*.

1. *In Substance.*

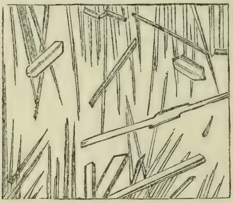
The crystals are transparent, colourless, or nearly so, not deliquescent, very sour in taste, soluble in their own weight of hot, and in about eight times their weight of cold water; also in

alcohol. When heated on platinum foil, they are wholly dissipated. When heated on a plate of white porcelain, they yield a white sublimate at 180°, and melt at 280° Fahr.

They are flattened four-sided prisms, with dihedral or tetrahedral summits: and, when deposited from solutions of the acid, have the forms shown in fig. 135. They resemble the crystals of sulphate of magnesia and sulphate of zinc, so as to be occasionally confounded with them. But they are easily distinguished.

Oxalic acid has a sharp sour taste; the two salts are bitter; the solution of oxalic acid has a strong acid reaction; that of sulphate of magnesia is neutral, and that of sulphate of zinc slightly acid: oxalic acid is entirely dissipated by heat, or, if impure, leaves only a scanty residue; the two salts are fixed: liquor potassæ added to a solution of the acid produces no change; but it precipitates the white oxide from the sulphates of magnesia and zinc: the acid effervesces with solutions of the alkaline carbonates, but yields no precipitate, while the sulphates of zinc and magnesia give a white precipitate, without effervescence. Oxalic acid discharges the colour of ink; the other crystals do not. It is sufficiently distinguished from the citric and tartaric acids by the defined shape of its crystals.

Fig. 135.



Solution $\frac{1}{100}$.

2. *In Solution.*

The liquid is known to contain an acid by its action on litmus, and a vegetable acid, or acid salt, by yielding long slender prismatic crystals on evaporation; and these being dissipated by heat, prove the presence of oxalic acid. The absence of precipitate with nitrate of baryta shows that the acid was not sulphuric. Nitrate of silver throws down a white precipitate. Ammonia, in strong solutions, produces characteristic radiated crystals of oxalate ammonia. The characteristic tests by which the acid may be fully identified are the following:—

1. *Nitrate of Silver.*—This throws down an abundant white oxalate of silver, soluble in nitric acid and ammonia; which, when dried and heated on platinum foil, detonates, and is dispersed as a white vapour of finely divided metallic silver.

2. *Sulphate of Lime.*.—The salts of lime in excess give with oxalic acid a white precipitate, soluble in nitric and hydrochloric acids, but insoluble in the vegetable acids and in ammonia.

Sulphate of copper yields with oxalic acid a greenish-white precipitate of oxalate of copper. The soluble salts of lead also give a white precipitate—a fact of which we avail ourselves in the process for organic liquids.

3. *In Organic Liquids.*

As oxalic acid is not altered by contact with the animal textures or with food, and an antidote can rarely be given, the process for the free acid is comparatively simple. A ready method of detecting the presence of oxalic acid in organic mixtures is by dialysis through vegetable parchment. The crystalline oxalic acid diffuses through the water, and may be obtained by evaporation. Or it may be diffused into a solution of sulphate of lime, in which case the characteristic octahedral cystals of oxalate of lime will be formed.

The acid liquid, if dilute, may be filtered at once, but if not, we add distilled water, allow the liquid to stand for a time, filter, and concentrate by evaporation, and add acetate of lead till a precipitate ceases to be formed. This, the oxalate of lead, is then diffused through distilled water, and sulphuretted hydrogen gas transmitted through it for two hours. Black sulphide of lead is thrown down; and, this being separated by filtration, the acid remains in solution.

If carbonate of lime or magnesia had been given as an antidote, a modified process is required to detach the acid from the base. The solid matters must first be broken down, and brought to the consistence of a thin syrup by the addition, if needful, of distilled water. About a twentieth of its bulk of carbonate of potash must then be added, and it must be boiled for two hours. The resulting liquid contains soluble oxalate of potash, and insoluble carbonate of lime or magnesia, which being separated by filtration, the liquid that passes the filter will be a solution of oxalate of potash. The base is now to be neutralized with pure nitric acid, and the solution of acetate of lead to be added as long as any oxalate of lead falls. This being collected, and suspended in distilled water, is to be treated by sulphuretted hydrogen, the sulphide of lead filtered off, and the acid solution tested for oxalic acid.

If the antidotes have only partially neutralized the poison, so that the liquid has an acid reaction, the first process must be adopted for the liquid portion, the second for the solid matters.

As oxalate of lime exists in large proportion, but in small absolute quantity, in rhubarb, it is always possible to attribute its presence, when, in small quantity, to rhubarb taken medi-

cinally. The history of the case, with the previous symptoms and post-mortem appearances, will meet this objection.

A strong solution of oxalic acid stains black cloth a deep-brown colour without corroding it, it reddens the vegetable blues, and as it removes the colour of ink, it is used to discharge writing.

Quantitative Analysis.—Use for this purpose the oxalate of lead. One hundred grains correspond to 42 of the crystallized acid.

Experiments on Animals.—Large doses (such as ʒss) in strong solution, cause symptoms of irritant poisoning, and death from collapse in from two to twenty minutes. Black extravasated blood is found in the stomach, and there are marks of acute inflammation with hardening or softening of the lining membrane.

The effects of oxalic acid on animals have been investigated by Onsum, Cyon, and Hermann. According to the experiments of Cyon, when oxalic acid is injected into the circulation or peritoneal cavity of rabbits, it acts as a cardiac poison. Soon after injection the pulse becomes very weak and frequent, dyspnœa rapidly comes on, and death with convulsions. After death the heart is found dilated and full of blood. It seems to act on the intracardial ganglia (Hermann, 'Experimentelle Toxicologie').

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms in man vary with the dose and the concentration of the poison. When the dose is large, and the solution strong, they follow immediately on the swallowing. An intensely sour taste is soon followed by a burning sensation in the pit of the stomach, increased by pressure, with pain and constriction of the throat. Vomiting, sometimes of blood, but generally of a greenish-brown or black grumous matter, soon follows, and, if the patient survive several hours there is purging of a similar matter, sometimes tinged with blood. The remaining symptoms are those of collapse—extreme debility, pale and anxious countenance, cold and clammy skin, small and frequent pulse, and hurried respiration. There are also soreness of the mouth, inflammation and swelling of the tongue, constriction of the throat, painful deglutition, intense thirst, restlessness, difficulty of breathing, and harassing cough. Cramps and numbness of the legs and arms, acute pain in the head and back, delirium and convulsions, are present in certain cases.

These symptoms are subject to many anomalies and exceptions. Even pain has been absent, and vomiting has not occurred till emetics were given. A rash has appeared on the skin. In one case, leeches applied to the epigastrium soon fell off dead.

Post-mortem Appearances.—The external appearance of the

body is natural, and the countenance pale and composed. The lining membrane of the mouth and fauces is generally white, shrivelled, and easily detached, and a similar appearance extends into the gullet, which is contracted into longitudinal and transverse folds, while the epithelium is detached in small irregular patches, leaving a brown surface beneath. The tube sometimes closely resembles a piece of worm-eaten wood. (See figs. 49 and 50, p. 415.) The stomach contains a dark-brown, or greenish-brown, grumous matter, in appearance nearly resembling *meconium*, which also lines the œsophagus, and extends into the duodenum. In some cases the lining membrane is quite pale and free from rugæ; in others it is highly inflamed, and the rugæ strongly marked. It is easily stripped off, and in some instances has been extensively detached. Its vessels are minutely injected with black blood. (See fig. 51, p. 415.) Perforation is rare. In cases of some continuance, the small intestines present the same appearances as the stomach. The peritoneum has been found inflamed, and in one case the right pleura. The lungs are sometimes greatly congested, and in one instance there were some traces of inflammation in the brain.

Occasionally the most characteristic post-mortem appearances, like the symptoms during life, are absent.

Of poisoning by oxalic acid, Christison justly observes: "If a person, immediately after swallowing a solution of a crystalline salt, which tasted purely and strongly acid, is attacked with burning in the throat, then with burning in the stomach, vomiting, particularly of bloody matter, imperceptible pulse, and excessive languor, and dies in half an hour, or, still more, in twenty, fifteen, or ten minutes, I do not know any fallacy which can interfere with the conclusion that oxalic acid was the cause of death. No parallel disease begins so abruptly, and terminates so soon; and no other crystalline poison has the same effect."* The post-mortem appearances are scarcely less characteristic. The wrinkled and corroded gullet, the pale, shrivelled, and partially detached mucous membrane of the stomach, the dark veins ramifying on its surface, and the dark-brown grumous matter

* Of 11 cases of poisoning by oxalic acid reported in the Journals, 5 were accidental, and 6 suicidal. Of the accidental cases, 3 were by mistake for Epsom salts. Of 13 cases, 6 recovered and 7 died; 3 occurred in males and 10 in females. The duration of the fatal cases was as follows—2 of a quarter of an hour, 1 of twenty minutes, 1 of less than half an hour, and 1 of eight days. The average duration of the first 4 cases was about twenty minutes.

The reader is referred to the following cases: 'Med. Gazette,' i. 757; v. 704; xxvii. 870; xxxi. 491. 'London Medical Repository,' vi. 474; xi. 20; xii. 18. 'Lancet,' Dec. 15, 1827; vol. ix.; x. 512; xxxii. 748; xxxiii. 29. 'Guy's Hospital Reports,' vii. 353. 'Edin. Med. and Surg. Journal,' xxxiv. 67.

which fills its cavity, point strongly to the action of a powerful corrosive poison; while the absence of the coloured spots on the skin precludes the supposition of the effect being due to either of the mineral acids.

First Appearance of Symptoms.—When the quantity of the poison is considerable, and the solution concentrated, the symptoms begin immediately. If the quantity is small, and the solution weak, they may be delayed for some hours.

Fatal Dose.—Less than *half an ounce* has proved fatal (in the case of a lad æt. sixteen, about a drachm); but a smaller quantity has produced severe symptoms, and recovery has taken place after the administration of two or three times as much.

Fatal Period.—Death may take place in less than *ten minutes.* In one case, the subject of an inquest held by Mr Wakley, it must have been nearly instantaneous. Life has been prolonged to the twenty-third day, the dose having been half an ounce.

Mortality.—The majority of cases prove fatal. A small number recover under prompt treatment.

Treatment.—The proper antidote is chalk, suspended in water. Magnesia or its carbonate may also be used: in the absence of these the plaster of the apartment. Lime water and oil have been used with advantage; but the alkalies are inadmissible. Warm water may be given freely, after the use of the antidotes. If vomiting is not present, emetics of sulphate of zinc may be employed. The stomach-pump should not be used, or it should be introduced with the greatest caution.

BINOXALATE OF POTASH (*Salt of Sorrel—Essential Salt of Lemons*).

This salt is a constituent of wood-sorrel and of other plants. It is used for bleaching straw and removing ink stains, for which purpose it, or a quadroxalate of potash, is sold under the name of "essential salt of lemons" for three halfpence the half ounce. As a poison it is nearly as active as oxalic acid. It has been taken by mistake for cream of tartar.

Tests.—The salt consists of colourless rhombic prisms; has a sour taste, and strong acid reaction; and is much less soluble than oxalic acid, requiring forty parts of water for its solution. It resembles oxalic acid in yielding a white precipitate with nitrate of silver and sulphate of lime, and in its reactions with sulphate of copper and the salts of lead.

When the crystals are heated on platinum-foil, they leave a white ash of carbonate of potash, which effervesces with nitric

acid, forming nitrate of potash. When they are heated on a slab of porcelain, they sublime at 280° Fahr., and a superimposed disk of glass bears a sublimate of coarse white crystals.

Symptoms.—Those of poisoning by oxalic acid. In a case of recovery after taking a quarter of a teaspoonful, reported by Dr. F. C. Webb, there was burning in the throat, a red tongue, intense thirst, no abdominal pain, vomiting after the lapse of two hours, severe pain in the loins, dysuria, great weakness of the legs, pain in the head, and cramps in the hands and legs.

Post-mortem Appearances.—As in poisoning by oxalic acid.

Treatment.—That of poisoning by oxalic acid.

Fatal Dose.—Half an ounce.

Fatal Period.—Eight minutes, in a lady recently delivered.

Mortality.—Like oxalic acid, it has proved fatal in the greater number of cases.

TARTARIC ACID has been once or twice taken as a poison.

Tests.—This acid crystallizes in oblique rhombic prisms. It is colourless, and has a pleasant taste; is soluble in five or six times its weight of water, and less soluble in alcohol. When heated, it first fuses, and then burns with a light red flame, giving out a peculiar odour, and leaving an abundant deposit of carbon. It also deposits carbon when heated with strong sulphuric acid.

The solution deposits feathery crystals; yields no distinct precipitate with nitrate of silver; and gives with the salts of potash a white granular precipitate (the bitartrate); aided in dilute solutions by friction of the sides of the vessel with a glasss rod.

Experiments on Animals.—These prove that tartaric is much less active than oxalic acid. In full doses it destroys life in less than an hour, with great weakness, and palsy of the limbs.

Symptoms.—One ounce, dissolved in half a pint of warm water proved fatal to a young man in nine days, with the ordinary symptoms of irritant poisoning. There are no specific symptoms.

Post-mortem Appearances.—In the case just referred to, inflammation of the greater part of the alimentary canal.

Treatment.—By the same antidotes as oxalic acid, with the after-treatment proper to the class of irritants. The soluble salts of potash are not contra-indicated, as in poisoning by oxalic acid.

CITRIC ACID, as shown by experiments on animals, is a more active poison than the tartaric. In a case of poisoning by it, the treatment would be that proper to oxalic or tartaric acid.

III. ACONITE (*Aconitum Napellus, Monkshood, Wolfsbane, Blue-rocket*).

With the exception of the Aconitum ferox, which grows on the Himalayan mountains in India, the Aconitum napellus is the most active poisonous plant of the many that go by the name of *aconite*. Some have no poisonous property whatever. But not only is the Aconitum napellus, with this single exception, the most active poisonous plant bearing the name aconite, it is also, when compared with other poisonous plants, a very fatal one, and there is reason to believe that *aconitina*, the active principle of the plant, is the most deadly poison in existence.

Monkshood belongs to the Linnæan class and order *Polyandria trigynia*, and the natural order *Ranunculaceæ*, or *crowfoots*. It is a beautiful plant, from two to six feet in height, with dark green leaves, of very characteristic form, and a terminal spike of rich blue flowers. It grows on hilly ground in many parts of Europe, is supposed to be indigenous, and is often cultivated as a garden flower. Fig. 136 shows a cutting of the plant.

Fig. 136.

All parts of the plant are poisonous, but the root is the most active. Both *root* and *leaves* have been several times taken as poisons; and the *extract* and *tincture* have also proved fatal.

The leaves and root are in the British Pharmacopœia. The fresh leaves and flowering tops yield an *extract* of which the dose is from 1 to 2 grains; and the dried root a *tincture* ($2\frac{1}{2}$ ounces to a pint—dose, 5 to 15 minims) and a liniment (1 ounce to a fluid ounce).

The *leaves* are completely divided to the base into five wedge-shaped lobes, which are again divided into three, the segments being linear. They are not to be mistaken for the leaves of any other plant.

The *seeds* are numerous, three-sided, irregularly twisted, and wrinkled, of a black or dark-brown colour, a sixth of an inch long, weighing 25 to the grain. Fig. 137 shows their size and shape, and fig. 138 the markings on their surface, as seen under the microscope. A single seed contains enough of the active principle of the plant to produce numbness and tingling of the lips, tongue, and throat.

Fig. 137.

Fig. 138.

The *root* has more than once been scraped and eaten instead of the horse-radish. This accident occurred in 1836 to a Mr. and Mrs. Prescott and their child, whose cases are minutely described by Pereira; in 1842 to a lady residing at Lambeth (Taylor); in the winter of 1853 to two brothers, of whom one died and the other recovered. Still more recently, in the winter of 1856, the poison killed two priests at Dingwall, and a third person out of five who were affected at a dinner there. In the next year, 1857, a case occurred in London. The recorded cases are now very numerous. The root has also been given intentionally in one instance at least.

It is not easy to understand how the root of monkshood should be mistaken for that of the horse-radish, even if the respective plants were not attached to the roots; for though the section of both roots is white when fresh, the scrapings of monkshood are friable and succulent, those of the horse-radish tough and stringy, and the first soon acquire a pink hue while the second remain white. The two roots differ in shape, colour, and taste. The root of monkshood is conical, and throws off a large number of curling fibres, and it is not unusual to find one or more pear-shaped tubers, attached by narrow necks to the upper part of the root-stock, as in the specimens shown in fig. 139, which, with the single root in fig. 140, were selected out of a large number of fresh roots of Aconitum napellus, as presenting the most characteristic varieties of form. The figures are of the size of the roots themselves; but it must be understood that the single root may attain two or three times the size depicted in fig. 140. On the other hand, the root, or, as it is commonly called, the stick of the horse-radish (fig. 141), is cylindrical in all its larger branches, and throws off straight rootlets. The colour of the monkshood-root is a dark nut-brown externally, that of the horse-radish is buff-coloured. The root of the monkshood, when chewed, soon causes a peculiar tingling and numbing sensation in the lips, with

Fig. 139.

Fig. 140.

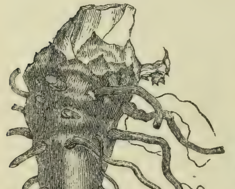


Fig. 141.

a feeling of enlargement, and a similar sensation in the throat, when swallowed; and this sensation continues for several hours: the taste of the horse-radish is pungent and sweet; causing profuse lachrymation, but not being very persistent.

This peculiar numbness and tingling of the lips is produced by the leaves and seeds, and, indeed, by every part of the plant.

The different species of aconite contain active principles which differ somewhat in chemical characters and activity, but the Aconitum napellus owes its activity to an alkaloid, *aconita* or *aconitine.* This occurs generally as a white amorphous powder. A crystalline form also exists—Morson's or English aconitine, said to be prepared from the Aconitum ferox, and termed Pseudaconitin or Nepalin.

The ordinary aconitine is sparingly soluble in water, but readily soluble in alcohol, ether, amylic alcohol, benzol, and chloroform. It forms salts with acids which are not crystalline. It gives precipitates with the general reagents for alkaloids (p. 397) with the exception of chloride of platinum. When heated on porcelain it readily melts into a yellow liquid, gives off a light vapour, and spreads into an abundant carbonaceous layer. It melts at 140° F., and at 400° yields sublimates which are not crystalline.

Special Characters.—*a.* A peculiar numbness and tingling when applied to the lips, tongue, or palate. *b.* Sulphuric acid dissolves it at first without colour, or with a faint yellow colour, which gradually passes through brown and red-brown to a violet-red which lasts a long time. *c.* A similar violet colour is produced by cautiously evaporating the alkaloid with officinal phosphoric acid. Dilute sulphuric acid produces the same effect, but the phosphoric acid is the more characteristic, as sulphuric acid produces a similar colour with other alkaloids. Aconitia may be separated from organic liquids by the Stas-Otto process already described (p. 396).

In the fresh root the alkaloid is contained in the proportion of a quarter to three-quarters of a grain in the ounce, and in the dried root, of twelve to thirty-six grains to the pound.

Experiments on Animals.—These have been made with monkshood, and its active principle aconitina, but there is considerable discrepancy in detail regarding the effects of aconitina, depending to a large extent on the differences in composition of the alkaloid used. The English aconitina is much more powerful than the French or German. According to Dr. Fleming,* aconite, when introduced into the system of one of the lower animals, causes,

* An Enquiry into the Properties of the Aconitum Napellus.

successively, weakness of the limbs, and staggering; accelerated, or slow and labouring respiration; paralysis; diminution, or total loss, of sensibility of the surface; dimness of vision, or actual blindness; increasing difficulty of breathing; and, after a few spasmodic twitches, death by asphyxia. Headland* ascribes death to paralytic syncope. Duckworth† regards the cause of death as a combination of syncope and asphyxia in small doses; and syncope proper in larger doses. Both these observers noted copious salivation and vomiting in the animals experimented on, in addition to the affection of the heart, respiration, and sensory and motor functions. Fleming found the pupils usually contracted. This also was observed by Duckworth, while Headland and others have described the pupils as dilated. Apparently the state of the pupils is not constant, and contraction may give place to dilatation before death.

Aconite exerts a very decided action on the heart, but some points of difference exist among experimenters as to its exact influence. Apparently there is at first a slight retardation of the heart's action by stimulation of the vagi, followed by increased rapidity with loss of power, ending in complete paralysis in a state of diastole. The paralysis of the heart accounts for the dyspnœa and convulsions which are observed. As regards the action of aconite on the nervous system and the motor and sensory functions, it is stated by some that the effect is primarily on the spinal centres, by others that it is due to direct action on the peripheral, sensory, and motor nerves. Death is the result mainly of the cardiac paralysis, which may manifest itself as syncope, or with dyspnœa and convulsions.

The *symptoms* of poisoning by monkshood in the human subject are:—numbness, tingling, and burning heat in the mouth, throat, and stomach, followed by nausea and vomiting, with pain and tenderness of the epigastrium. The numbness and tingling speedily become general, with diminished sensibility of the surface, vertigo, dimness of vision, or complete blindness, tinnitus aurium, and occasionally deafness; frothing at the mouth; sense of constriction in the throat, with sensations of weight and enlargement of various parts of the body, but especially of the face and ears; great muscular feebleness, with general tremor; more or less difficulty of breathing, and speechlessness; a distressing sense of sinking at the pit of the stomach, and dread of approaching death. The pulse becomes small, feeble, irregular, and finally imperceptible both at wrist and heart; the extremities, and after-

* 'The Action of Medicines,' 1867.
† 'Brit. Med. Jour.,' March 2, 1861.

wards the whole body, become cold, and a clammy sweat bedews the surface; finally, the countenance grows blanched, the pupils dilated, the lips bloodless, and, with a few hurried gasps, the individual expires. The mental faculties usually remain perfect till the last, but there may be slight delirium with convulsions. There is no tendency to sleep. Death is often sudden.

Post mortem Appearances.—General venous congestion, and, in some cases, engorgement of the brain and its membranes, with considerable sub-arachnoid effusion; also occasionally signs of gastro-intestinal irritation. But these appearances are not characteristic.

Commencement of Symptoms.—In a few minutes, or not for one or two hours.

Fatal Period.—Shortest, an hour and a quarter; longest, twenty hours; average, less than four hours. The majority of deaths occur within three hours.

Fatal Dose.—Of the root, it is believed that less than a drachm has proved fatal; of the alcoholic extract, four grains; of the tincture, a drachm. But very severe symptoms have been produced by much smaller quantities. According to Headland's experiments, aconitine is so active that $\frac{1}{300}$ grain will kill a mouse; $\frac{1}{100}$ a small bird in a few minutes, and $\frac{1}{50}$th almost instantaneously; $\frac{1}{70}$th of a grain a cat, and $\frac{1}{10}$th of a grain the same animal in twenty minutes or half an hour. Headland is of opinion that $\frac{1}{10}$th of a grain will kill an adult, and Herapath performed an analysis in a case at Bristol, from which he inferred that $\frac{1}{20}$th of a grain had proved fatal; $\frac{1}{1000}$th of a grain causes tingling and numbness of the tip of the tongue, and $\frac{1}{100}$th dissolved in spirit and rubbed into the skin causes loss of feeling, lasting for some time.

Treatment.—The treatment will consist in the prompt administration of an emetic, followed, after an interval of time, by a full dose of castor oil. Stimulants, such as hot brandy and water and ammonia, must then be freely administered, and strong coffee may be given with advantage. Dr. Fleming also recommends friction of the spine and limbs with warm cloths and spirituous liniments, and sinapisms, or bottles of hot water, to the præcordia and extremities; and that convulsions, if they come on, should be treated by opening the jugular vein; and great dyspnœa, and extreme feebleness of the heart's action, by artificial respiration, and slight galvanic shocks passed through the heart.

Dr. Fothergill has called attention to the fact that the heart of frogs poisoned with aconite can again be made to contract by the application of digitalis, thus indicating some sort of physio-

logical antagonism. A most interesting case of the successful application of this view to poisoning with aconite in the human subject, has lately been recorded by Dobie ('Brit. Med. Journ.,' Dec. 21, 1872). A patient had swallowed one ounce of Fleming's tincture, and was at the point of death; but by the subcutaneous injection of 20 minims of tincture of digitalis, and, after twenty minutes, the administration by the mouth of a drachm along with ammonia and brandy (twice repeated within an hour), complete recovery took place. This case affords good reason for the future employment of digitalis in poisoning by aconite.

Diagnosis.—In some instances we are able to identify portions of the plant itself in the alimentary canal. An alcoholic extract of the contents of the stomach, applied to the lips, produces the peculiar numbness and tingling already described, and if given to some small animal would be identified by its fatal effects.

IV. DIGITALIS (*Digitalis purpurea—Foxglove, Purple Foxglove*).

Fig. 142.

This is an indigenous plant, common about banks and hedgerows, and in pastures on a gravelly or sandy soil. It is also cultivated for its elegant shape and purple dotted flowers (fig. 142).

It belongs to the Linnæan class and order *Didynamia angiospermia,* and natural order *Scrophulariaceæ,* or figworts.

All parts of the plant are believed to be poisonous, and the leaves have more than once destroyed life.

The dried leaves have a place in the British Pharmacopœia; and yield an infusion (30 grains to 10 ounces; dose two to four drachms) and a tincture (two ounces and a half to a pint; dose, ten to thirty minims.)

The *root* consists of numerous long slender fibres, and is not likely to be confounded with any of the common edible roots.

The *leaves* are ovate, narrowed at the base, crenate, rugose, and veined, downy, especially on the under surface. The dried leaves have a dull green colour, a faint odour, and a bitter nauseous taste.

The *seeds* are of the small size shown in 4, Fig. 45, p. 394; and weigh about 1,126 to a grain. They are of a light brown colour, cylindrical, ovoid, or conical in shape, and when viewed

by the lens or microscope, present a pitted appearance. They resemble the seeds of the Lobelia inflata in colour, but are somewhat larger, and differ widely in microscopic character.

Digitalis owes its activity to an active principle, or rather, a mixture of different active principles, termed *digitaline*. In chemical composition it belongs to the glucosides. Like the alkaloids it is precipitated from its solutions by tannin. Digitaline is met with either white and amorphous, or of a yellowish colour. It is sparingly soluble in water, and has an intensely bitter taste. It is readily soluble in alcohol, amylic alcohol, and chloroform. It may be extracted from acid and alkaline solutions by ether, but chloroform is the best solvent.

When heated on porcelain it darkens, melts slowly into a brown liquid, yields an abundant thick vapour, and swells into a bulky black ash. The vapour has the odour of the drug. It swells and sublimes at 310° F. The sublimate is not characteristic.

Tests.—*a.* Sulphuric acid changes it to a reddish-brown, which deepens when the solution is warmed, and still more so in heating. *b.* The solution in sulphuric acid mixed with a trace of bromine (according to Otto, best effected by stirring it with a glass rod dipped in water standing over bromine,) gives a violet-red colour resembling the petals of the flower. *c.* Heated with strong hydrochloric acid, it turns greenish or brownish. *d.* The physiological test described below,—viz., the action on the frog's heart.

Experiments on Animals.—In moderate doses digitalis causes vomiting, giddiness, languor, and death in twenty-four hours. In larger doses, in addition to these symptoms, tremors, convulsions, stupor, and coma. Injected into the veins, it kills in a few seconds, by acting on the heart and pulmonary circulation. In one of Mr. Blake's experiments, an infusion of three drachms of the leaves injected into the jugular vein arrested the action of the heart in five seconds, that organ after death being motionless, turgid, inirritable, and its left cavities full of florid blood.

Digitaline acts specially on the heart and vascular system. The heart's action is at first strengthened and the pulse retarded, while the blood pressure is raised by contraction of the blood-vessels. Later, a paralytic condition both of the heart and blood-vessels ensues. In very large doses paralysis of the heart's action comes on rapidly without a previous stage of stimulation.

The interesting experiments of Drs. Fagge and Stevenson* have shown that the substance shares with the veratrum viride,

* 'On the Application of Physiological Tests for certain Organic Poisons, and especially Digitaline;' Guy's Hospital Reports, 3rd Series, vol. xii. p. 27

squill, and one or two other poisons, the power of acting on the frog's heart in a characteristic manner, causing a peculiar form of irregularity in its beats, the stoppage of the ventricle in the white, contracted state, and the retention of the voluntary power when the heart stops, and for at least 15 to 20 minutes afterwards.

The quantity of the alkaloid in the leaves is less than one per cent.; and it is believed that a dose of $\frac{1}{16}$ grain would produce symptoms of poisoning in an adult.

Symptoms.—In the human subject, a single fatal dose occasions:—Vomiting, purging, and severe colicky pains; pain in the head, giddiness, and dimness of vision, or actual blindness; a dilated and insensible pupil; a slow, weak, and irregular, or intermittent pulse; nausea and faintness, with occasional syncope; the skin covered with a cold perspiration; the patient is much worse when he assumes the upright posture. Salivation is a common occurrence. The urine is suppressed; convulsions occasionally occur: and the patient sometimes continues for a long time in a state of stupor. In two fatal cases death took place in twenty-two hours. When the poison is not fatal, the recovery occupies several days, and the circulation is slowly restored to its normal state.

The *Post-mortem Appearances* are turgescence of the vessels of the brain, and redness of the membrane of the stomach.

Occasionally, in the practice of medicine, serious symptoms show themselves, without terminating fatally. These are dryness in the throat, and thirst; nausea; headache; salivation; giddiness, and dimness of sight, an appearance of sparks before the eyes, and a feeling of pressure on the eyeballs, with weakness of the limbs, and a weak and rapid pulse.

The symptoms arising from the gradual accumulation of the poison are nausea, dryness of the mouth, loss of appetite, vomiting, and intense thirst; giddiness, and throbbing of the temples; restlessness and sleeplessness; a hot and moist skin; great languor and depression, with, in most cases, a slow pulse. Diarrhœa, salivation, an increased flow of urine, delirium, spectral illusions, convulsions, and coma, are occasional symptoms.

Fatal Dose.—This has not been ascertained. No poison in common use is of more uncertain operation; and in the treatment of inflammatory diseases, as well as in delirium tremens, it is often administered in doses which would be very unsafe in a state of health. Pereira cites several cases, both in children and adults in which the tincture of digitalis was given in such doses as twenty drops three times a day to an infant, and from half an ounce to an ounce to an adult; but in these cases the natural

operation of the poison was counteracted by disease accompanied by decided febrile action, or by intoxication attended by great excitement of the circulation.

There is one case on record of homicidal poisoning by digitaline, viz., that of the woman Pauw, poisoned by Dr. De la Pommerais in 1864. This woman died with all the symptoms of poisoning by digitalis, and though after death digitaline was not detected chemically, yet the action of an alcoholic extract of the contents of the stomach and of matters which the deceased had vomited on the floor, produced in animals such symptoms, viz., vomiting, and slow pulse, as pointed strongly to poisoning with digitaline. De la Pommerais was found guilty.

The *treatment* will consist in the use of emetics, followed by aperients, and by the free use of vegetable infusions containing tannin, such as infusions of nutgalls or of oak-bark. These are given with a view of rendering the *digitaline* inert. Green tea, or strong coffee may also be given with advantage. Stimulants, such as ammonia, wine, and brandy, should also be administered, and the recumbent posture be strictly preserved. Friction to the spine, though less indicated than in poisoning by aconite, or when asphyxia is imminent, might be used with advantage; and, in desperate cases, artificial respiration, and galvanic shocks through the heart.

V. VERATRUM ALBUM (*White Hellebore*).—VERATRIA.

The *veratrum album*, or white hellebore (natural order Melanthaceæ) is not an indigenous plant, but grows abundantly in the mountain districts of the Continent. (Fig. 143.) Every part of it is poisonous; but the powdered root, or an infusion from it, has been most commonly taken as a poison. The powder has nearly the colour of powdered jalap, has an acrid, bitter taste, and strongly irritates the nostrils. Hence its use, mixed with starch, as an errhine; but its principal use is to destroy vermin on the skin or hair.

The plant owes its activity to the alkaloid *veratria*. Veratria is also found in the Cebadilla (the fruit of the *Asagrœa officinalis*).

VERATRIA (*Veratrine*).—This alkaloid is prepared from the Cebadilla (British Pharm., p. 365), and is the active ingredient in the unguentum veratriæ (8 grains to 1 ounce). When pure, it is a white amorphous powder, without odour, but highly irritating to the nostrils, and of an intensely bitter and highly acrid taste.

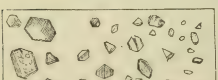
It is insoluble in water; but more or less readily dissolved by alcohol, ether, chloroform, benzole, and fusel oil. It has a

Fig. 143.

Fig. 144.

slightly alkaline reaction, and forms soluble salts with the acids. Strong sulphuric acid first turns it yellow, then a rich crimson, the change taking place instantaneously when the acid is gently heated. Heated with concentrated hydrochloric acid for some time, it turns a beautiful red (Trapp). Veratria mixed with six times its weight of sugar, and moistened with strong sulphuric acid, turns yellow, then green, and after a time blue (Weppen). When heated on a porcelain slab it darkens, melts readily into a yellow liquid, blackens, and spreads into an abundant carbona-

Fig. 145.



ceous layer. The vapour has a disagreeable pungent odour; and, when received on a clean disk, deposits detached crystalloids, or crystals described as rhomboidal, but among which several octahedra can be discovered. These crystals, in two degrees of enlargement, are shown in fig. 145. When heated on platinum-foil, the alkaloid is entirely consumed.

The symptoms of poisoning by veratrum album, and veratria, are in all respects similar.

Symptoms.—Locally applied, the powder and alkaloid irritate the mucous membranes of the nose and mouth, causing violent sneezing and salivation. When swallowed they cause a burning sensation in the stomach, with nausea, vomiting, and diarrhœa. The constitutional effects are a remarkable depression of the heart's action, the pulse becomes imperceptible, the skin pale and cold, and death takes place usually in a state of insensibility with convulsions.

Experiments on Animals.—Two grains of veratria in solution given to a cat, began to act immediately, causing frothing at the mouth and collapse, and death in less than a minute. Three grains given to a young dog, caused immediate and repeated vomiting, involuntary discharge of urine, great prostration, and death in two hours.

The effect of veratria on the heart and circulation is apparently a constant phenomenon in all animals. It lowers the pulse and energy of the heart. In the frog, the heart is brought to a stand-still in a state of paralysis, and is no longer capable of being excited by galvanic stimulation. The influence on the heart is complex, being partly due to its action on the cardiac nervous apparatus, and partly to a direct action on the muscular tissue of the heart itself.

Post-mortem Appearances.—Marks of acute inflammation in the alimentary canal.

Treatment.—The prompt use of the stomach-pump, or, in the absence of vomiting, emetics of sulphate of zinc. Vegetable infusions containing tannin, as an antidote, or finely-divided charcoal. The collapse to be met by diffusible stimulants and by opium, which seems to have been useful in some cases.

Fatal Dose.—A fraction of a grain. A sixteenth of a grain has produced a state of dangerous collapse (Taylor).

Fatal Period.—It may be inferred from experiments on animals, that death would be very rapid.

The *veratrum viride*, or green hellebore (fig. 144), possesses poisonous properties resembling those of the veratrum album. It furnishes to the British Pharmacopœia a tincture of which the

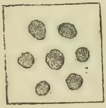
dose is from 5 to 20 minims. It appears also to be a poison in common use in North America, where it is known as "Indian poke." It produces in poisonous doses the same depressing effect on the heart and circulation, and may cause death from fatal collapse. It is said to be less irritating to the alimentary canal.

Bullock has obtained from it two alkaloids, *viridia* and *veratroidia,* the action of which has been experimentally investigated on animals by Wood ('Amer. Journn. of Med. Sc.,' cxvii.). Both act on the heart, but veratroidia appears to have a more marked irritant action than viridia. Veratroidia, however, appears, from the remarks of Wormley,* to be identical with veratria; and the viridia of Bullock is the same as *jervia,* another alkaloid also contained in veratrum album. Jervia differs from veratria in its reaction with sulphuric acid. Sulphuric acid turns it yellowish or yellowish-red, and after some minutes a bright green colour.

VI. COLCHICUM (*Colchicum autumnale, Meadow Saffron*).

This plant grows in moist meadows in every part of Europe. It flowers in autumn, and throws out its leaves in spring; and it has a fibrous root attached to the under side of an underground stem or corm. The fruit, which ripens about midsummer, contains several hard brown seeds. Fig. 147 shows the plant (A), the flower (B), and the capsule (C). The corm and seeds are used in making several preparations of the British Pharmacopæia —the fresh corm for the extract and acetic extract, the dried corm for the wine, and the seeds for the tincture. The corms have been taken by mistake for onions; and the seeds, wine, and tincture have also been taken in poisonous doses.

Fig. 146.



The seeds of colchicum are globules of a reddish-brown colour, very hard, and shrivelled on the surface, of the size shown in the figure, and weighing eight, ten, or twelve to the grain.

Colchicum owes it activity to an alkaloid, *colchicin* or *colchicina.*—It is a yellowish white powder readily soluble in water, forming an intensely yellow solution. It is soluble in alcohol, but less so in ether. It is precipitated by the general reagents for alkaloids. It forms salts with acids, but ether extracts the alkaloid from the acid solution—wherein it differs from the other alkaloids.

* 'The alkaloids of veratrum viride, and album,' Philadelphia, 1876.

Tests.—1. Nitric acid turns it a violet tint, which passes into a brownish colour. 2. Sulphuric acid turns it a bright yellow.

Experiments on Animals.—Colchicin given to animals produces irritation of the alimentary canal, and according to Schroff, also acts as a cardiac poison. Rossbach states that it acts on the sensory nerves. There is however room for further investigation on this subject.

Fig. 147.

Symptoms.—The symptoms are sometimes slow in showing themselves. Two or more hours may elapse after swallowing the poison before the symptoms appear, while on the other hand they may begin almost immediately, and death may occur in so short a time as seven hours. The symptoms are pain and contraction of throat, pain in the epigastrium, and violent vomiting and purging. Then follows profound prostration and collapse, with cold skin and imperceptible pulse. Usually the mental faculties are intact, but there may be delirium and convulsions.

Fatal Period. — Colchicum is seldom fatal within 24 hours. Three or four days not unfrequently elapse.

Post-mortem Appearances. — There are usually indications of gastro-intestinal irritation, but there are no other characteristic appearances.

Fatal Dose.—Five patients, under the care of M. Roux, of Toulon, died from the effects of *two ounces* of colchicum wine, given to each in mistake for wine of bark. Major* reports the case of 17 thieves who swallowed quantities varying from 3 to 11 ounces of a colchicum wine made with four ounces of the seeds to a pint. Seven died, ten recovered.

Treatment.—That proper to the state of collapse.

* 'Med. Times and Gazette,' March 7, 1874.

CHAPTER XV.

ASPHYXIANTS.

1. Carbonic acid, Carbonic oxide, and the Products of Combustion.
2. Coal gas.
3. Nitrous oxide.
4. Sulphuretted hydrogen, and Sewer Gases.

The term "*asphyxiants*," placed at the head of this chapter, is used in the same sense as the words "narcotics," "deliriants," "inebriants," which distinguish other chapters. The gases are poisonous agents applied to the air-passages, and causing suffocation as a leading and conspicuous symptom, but, at the same time, giving rise to headache, giddiness, drowsiness, insensibility, and failure of muscular power, and, in exceptional cases, to spectral illusions, delirium, and maniacal violence, showing their direct action on the nervous system. In a state of concentration these gases may cause spasm of the glottis, and consequent death by suffocation; but, as usually inspired, they are largely diluted with atmospheric air, and not uncommonly mixed with other purely irritant or otherwise deleterious gases.

I. CARBONIC ACID.

Carbonic acid is a colourless gas, inodorous, but pungent to the nostrils. It is much heavier than atmospheric air, with which it mixes slowly. It is soluble in water, has the reaction and other properties of an acid, and combines with lime to form chalk.

Tests.—*a*. It produces a milkiness, followed by a white precipitate, in lime water. *b*. It does not support combustion; and when mixed with air, in the proportion of from ten or twelve to fifteen or twenty per cent., extinguishes flame. For a small flame as little as ten or twelve per cent. will suffice. *c*. Litmus paper moistened with bleaching liquid is first reddened, and then bleached by the gas as it exists in the air. A jet of carbonic acid is easily recognised by its pungent effect on the nostrils.

The property of combining with lime is turned to practical account in purifying the air of wells or pits. A vessel of lime, mixed up with water into a thin paste is lowered into the stratum of gas. The same result may be obtained by a current of air or jet of steam.

Quantitative Analysis.—The quantity of carbonic acid in the air may be determined by the amount of absorption that takes place in a graduated jar containing liquor potassæ. The gas may be collected for analysis by emptying a full jar of water into the space containing it. The quantity of charcoal that has been burned in any case may be estimated at from twenty to twenty-five times the weight of ash.

Carbonic acid is generated in many different ways. It accumulates in large quantities almost undiluted, in pits, cellars, wells, mines (especially after explosions, constituting the 'choke-damp' of miners), volcanic grottoes, fermenting vats, lime-kilns, &c. A continuous source of carbonic acid is the respiration of animals and the combustion of fuel. The gradual exhaustion of oxygen and proportionate accumulation of carbonic acid in ill-ventilated apartments is one of the factors of the evil results of bad ventilation, but not the only one, as other animal exhalations are also injurious. As a rule, excess of carbonic acid implies corresponding deficiency of oxygen, and the proportion cannot exceed 10 per cent. without rapidly fatal consequences; but much less than this may prove fatal, and less than two per cent. cannot be breathed for any length of time with impunity. If the amount of oxygen be not proportionately diminished, carbonic acid will still prove fatal if present in sufficient quantity. Thus Bernard found that a bird died instantaneously in an atmosphere of equal parts of oxygen and carbonic acid, and Snow proved that 20 per cent. of carbonic acid, in an atmosphere containing the normal amount of oxygen, soon proved fatal to small animals, and that even 12 per cent. might cause death ultimately.

Symptoms.—Undiluted carbonic acid is not readily inhaled, as it induces spasm of the glottis. Immersion in an atmosphere of pure carbonic acid is rapidly fatal. The individual falls down suddenly prostrate and insensible, and death occurs almost immediately. Sudden death in this manner not unfrequently occurs when labourers incautiously descend into an old well, or a region filled with choke damp, and more than one may fall victims, as one goes searching after the other and meets a similar fate.

When carbonic acid is inhaled in a diluted form, it causes headache, giddiness, and a sense of oppression, followed by ringing in the ears, and drowsiness. This passes into a state of stupor and

insensibility, with stertorous respiration. Death occurs in this comatose condition quietly, or occasionally with convulsions.

If the excess of carbonic acid coincides with a corresponding deficiency of oxygen, the phenomena are in all respects those of asphyxia.

Carbonic acid is not merely a negative asphyxiant like hydrogen or nitrogen, but acts like a narcotic on the nerve centres.

Post-mortem Appearances.—These are essentially those of asphyxia. The brain is more frequently congested than in asphyxia from mere obstruction of the respiration. The blood is dark and fluid. The hæmoglobin is completely reduced. Animal heat is said to be retained long after death, and rigidity is well marked and enduring.

Treatment.—Prophylactic. Caution should be exercised in exploring wells and mines where there is a likelihood of carbonic acid accumulation. The introduction of a lighted candle into the atmosphere is a rough test of considerable practical value. The mere fact of a candle continuing to burn is no test of an atmosphere being respirable, for a candle will burn in an atmosphere containing 10 per cent. of carbonic acid, if oxygen is present in the normal amount, and the presence of a quantity of carbonic oxide, sufficient to cause death, will not materially affect the flame.

If carbonic acid, however, reaches the proportion of 16 per cent. the candle will be extinguished. If, therefore, a candle is extinguished, it is an indication that the atmosphere is not respirable for any length of time.

If carbonic acid is shown to exist, it may be expelled, in the case of wells, by sweeping them with an inverted umbrella, or by the direction of a jet of air or steam into closed spaces.

Restoratives.—The patient must be immediately removed from the infected atmosphere. Pure oxygen may be administered if at hand, and artificial respiration had recourse to if the respiratory movements do not occur spontaneously.

CARBONIC OXIDE.

Carbonic oxide is a much more dangerous agent than carbonic acid, and to it are mainly due many of the effects ascribed to the latter. This is especially so in the case of charcoal fumes, of which carbonic oxide is the active toxic constituent. Pure carbonic oxide is rarely generated out of the chemical laboratory.

Carbonic oxide is a colourless gas, almost insoluble in water, and burns with a pale blue flame. It is the flame of carbonic

oxide which is seen on burning charcoal. The carbonic acid of the burning charcoal passing over the heated embers, takes up another atom of carbon and is converted into carbonic oxide, which burns with a bluish flame at the top. Usually, charcoal fumes contain from 2 to 3 per cent. of carbonic oxide, and 25 per cent. of carbonic acid, with some carburetted hydrogen. The fumes of burning charcoal are, however, effective as a poison after being passed through lime-water, which fixes the carbonic acid.

Carbonic oxide also exists in coal gas, and is its chief poisonous constituent. It is likewise found in the emanations from brick-kilns.

Poisoning by charcoal vapour is not an uncommon form of suicide, particularly in France, and many cases have occurred accidentally in this country from sleeping in rooms without a flue with a charcoal fire burning, or into which there has been leakage from stove pipes.

Carbonic oxide is an extremely active poison. Letheby proved that five per cent. in the atmosphere killed small birds in three minutes, and that 2 per cent. killed a guinea-pig in two minutes. Many similar experiments have been performed on the lower animals with similar results. The animals rapidly become insensible, and die usually without any convulsive action beyond a few tremors or flutterings.

Symptoms.—In man inhalation of carbonic oxide for a short time, as Sir H. Davy and others have proved on themselves, causes headache and pulsation in the temples, giddiness, nausea, and great prostration. In fatal cases the individuals pass into a state of insensibility, or deep coma. Death usually occurs quietly, but in some cases convulsions occur. Vomiting is a common symptom.

In cases of recovery, after effects may continue for some time.

An instructive case of recovery, showing the effects of the gas on the nervous system, is related by Sir George Baker, on the authority of Heberden. A young man was shut up in the morning in a close room with burning charcoal, till two small birds fell down dead in their cages, when he felt so ill as to be obliged to go into the open air. This he had no sooner done, than he fell down senseless. When he came to himself, he complained of giddiness, sickness, pains in the stomach and loins, and stupor, lasting the whole day. Next day he felt better, but about 7 P.M. was seized with violent pain of the stomach and loins, vomited, threw himself on the ground, fell into convulsions, and could hardly fetch his breath. Soon after, having somewhat

recovered, he had a second fit of the same kind. About an hour afterwards he became delirious, and was with difficulty kept in bed during the night. In the morning he came to himself, and had some quiet sleep; but the pain was not quite gone, and giddiness, with strange sights before the eyes, continued for some little time longer.*

Glycosuria and albuminuria have been found to result from carbonic oxide poisoning.

Post-mortem Appearances.—Frequently the face has a florid tint. Reddish patches are seen in various parts of the body. The specially characteristic sign of carbonic oxide poisoning is a cherry red tint of the blood and of the internal viscera. Sometimes the cherry red tint of the blood is obscured, apparently in cases where much carbonic acid is also present.

The red tint of the blood is due to a chemical compound which carbonic oxide forms with the colouring matter of the blood. Carbonic oxide displaces oxygen and forms a very stable compound with the hæmoglobin. Hence the oxygen carrying power of the blood corpuscles is, as Bernard expresses it, paralysed.

The presence of carbonic oxide in the blood is capable of being demonstrated both spectroscopically and chemically. In the spectroscope, carbonic oxide blood exhibits two absorption bands, very similar in appearance to those of oxy-hæmoglobin, but they differ a little in breadth, and are situated somewhat nearer the violet end of the spectrum. Unlike ordinary blood, carbonic oxide blood is not capable of reduction by sulphide of ammonium, or reducing agents, in the usual manner.

Caustic alkalies, as Hoppe-Seyler points out, act differently on normal and carbonic oxide blood. With the latter, caustic soda causes a red colour when mixed with it on a white porcelain plate, while it turns ordinary blood of a green tint.

Treatment.—As carbonic oxide hæmoglobin is a very stable compound, and offers very great resistance to displacement by oxygen, artificial respiration is not of itself sufficient. The most successful results have followed venesection and transfusion of arterialized defibrinated blood.

II. COAL GAS.

Coal gas contains, in addition to olefiant gas and analogous hydrocarbons, on which the luminosity principally depends, certain

* An account of a singular disease which prevailed among some poor children, maintained by the parish of St. James, in Westminster, in the 'Medical Tracts,' by Sir George Baker, Bart., M.D., F.A.S., collected and republished by his son (1818), p. 616. For an abstract of this instructive case, consult Dr. Guy's 'Public Health,' p. 12.

so-called diluents which burn with a non-luminous flame—viz., hydrogen, marsh gas, and carbonic oxide, and also what are termed impurities, viz., carbonic acid, sulphuretted hydrogen, and sulphides of carbon. On these impurities, the characteristic odour mainly depends. This odour which is perceptible in 1 in 10,000, is a valuable safeguard against accidents from escape of gas.

A mixture of coal gas with the air inhaled, exerts a prejudicial effect on the system and proves fatal if it exceed a certain percentage. In addition to the danger from inhalation, fatal accidents frequently occur from the explosive nature of the compound which is formed when the gas reaches the proportion of 1 to 10 of the atmosphere. Such accidents happen when a gas leakage is looked for with a naked light, or when a new gas main is ignited before the whole of the atmospheric air has been expelled. In July, 1880, an alarming series of underground explosions, widely separated from each other, occurred from this cause, near Tottenham Court Road. It is difficult to determine the exact proportion of the gas present in atmospheres which have proved fatal, but experiments on animals throw important light on this point. M. Tourdes finds that pure gas is almost instantaneously fatal; $\frac{1}{8}$th kills rabbits in five minutes, and dogs in twelve minutes; $\frac{1}{15}$th kills rabbits in from ten to fifteen minutes; $\frac{1}{30}$th still proves fatal after a longer period, and evident signs of distress are caused in rabbits by an atmosphere containing only $\frac{1}{50}$th of the gas. Dr. W. Taylor ('Edin. Med. Jour.' July, 1874) has estimated the proportion of gas existing in a room in which a fatal case occurred at three per cent.

Poisoning by coal gas is known only as an accident. Occasionally suddenly fatal consequences ensue among workmen from exposure to a sudden rush of undiluted gas from gasometers and mains. More commonly, slowly fatal cases occur from the gas tap in a room being carelessly left open, from accidental extinction of the light, or by leakage from gas pipes either in the house or at a distance, the gas gaining access to the house by means of drains and sewer pipes.

Symptoms.—Coal gas, when in small proportion and just sufficient to indicate its presence by its odour, causes headache and general depression of health if long breathed. In some fatal cases the symptoms have been headache, nausea, and vomiting, giddiness, drowsiness passing into complete coma, with livid features, stertorous breathing and other phenomena of the apoplectic state. Death occurs in this state of coma with or without convulsions.

The state of the pupils is not constant. Generally they are dilated before death. In Taylor's case, already alluded to, the

teeth were firmly clenched, and the eyeballs were in a constant state of lateral oscillation.

Fatal Period.—The fatal period is very variable, and a remittent character of the symptoms sometimes gives rise to fallacious hopes of recovery in cases which ultimately prove fatal.

Diagnosis.—The smell of gas in the clothes, breath and perspiration, which continues for a considerable time after removal from the impure atmosphere, is the best indication of the cause of the coma.

Post-mortem Appearances.—The smell of gas is often very marked. M. Tourdes describes as the most constant appearances a dark colour of the blood, a bright colouration of the pulmonary tissue, froth in the air-passages, and congestion of the base of the tongue, engorgement of the cerebral and spinal veins, and rose-coloured patches on the thighs.

Mode of Action.—Coal gas being a complex mixture, it is obviously impossible to differentiate the effects due to each constituent, but there is good reason for believing that the most active agent is the carbonic oxide, which exists in coal gas in the proportion of from 5 to 25 per cent. The symptoms in the main agree with those of poisoning by carbonic oxide; and the effects therefore would be ascribable to the action of the carbonic oxide on the blood colouring matter.

Treatment.—The treatment is that for carbonic oxide poisoning.

III. NITROUS OXIDE (*Laughing Gas*).

Nitrous oxide, prepared by the distillation of ammonium nitrate, is now largely used as an anæsthetic; and so used it has proved fatal in one or two cases.

Symptoms.—When nitrous oxide is inhaled, mixed with atmospheric air, it gives rise to a peculiar state of intoxication, often of a hilarious nature (hence the name laughing gas). When administered undiluted, for a minute or two, a state of insensibility comes on, during which short operations, such as the extraction of teeth, can be performed without pain. During this state of insensibility the face becomes livid and the pupils dilated. If the inhalation be continued, dangerous, and even fatal symptoms of asphyxia manifest themselves.

Animals made to breathe an atmosphere of nitrous oxide die with all the symptoms of asphyxia. The anæsthesia produced by nitrous oxide is considered to be chiefly due to its action as an asphyxiant, and not to any special narcotic power, but the feeling of exhilaration caused by it seems to indicate that it is not to be regarded merely as a passive agent.

Purcell ('Phil. Med. and Surg. Report,' 1872, p. 343) reports a case of death from the use of nitrous oxide in dentistry. Death was sudden, but it was doubtful how much of the fatal result was due to asphyxia and how much to shock. A similar case occurred at Exeter in 1873 ('Brit. Med. Jour.,' Feb., p. 126), which gave rise to much dispute as to the cause of death. As a post-mortem examination was not allowed, it is impossible to say what share the nitrous oxide really had in the untoward result.

Treatment.—The treatment is that for asphyxia generally. *See* CHLOROFORM, p. 562.

IV. SULPHURETTED HYDROGEN (*Hydrosulphuric Acid*).

This gas ranks next in importance to carbonic acid. It is scarcely less generally diffused, but its offensive odour gives warning of its presence. It is an extremely active poison, for according to Thénard, atmospheric air which contains $\frac{1}{1500}$th of its volume will destroy a bird; while $\frac{1}{800}$th of its volume it will kill a dog; and $\frac{1}{250}$th prove fatal to a horse. Injected into the blood, it speedily destroys life; and it proves fatal when introduced into any of the cavities of the body, or even when applied to the unbroken skin. Sometimes it is generated in the intestines or in putrid abscesses, and being absorbed into the blood causes septic symptoms.

Properties.—This gas has a peculiarly offensive odour—that of rotten eggs; and it is remarkable for the variety of its reactions with the metallic bases. It combines with ammonia to form the sulphide of ammonium, which has a similar offensive odour added to the pungency of hartshorn, and similar chemical reactions. The presence of ammonia is indicated by the fumes given out when a rod dipped in hydrochloric acid is held in the gas.

Tests.—The usual test for this gas is acetate of lead, which throws down a brown or black precipitate, according to the quantity of the gas. Filtering paper moistened with a solution of the salt of lead is a very delicate test.

Symptoms.—When the gas is breathed in a moderately diluted state, it causes giddiness, a sensation of tightness across the temples, and of oppression at the pit of the stomach, nausea, sudden weakness, and loss of sense and motion. Delirium, tetanus, and convulsions, a cold skin, an irregular and very frequent pulse, and laborious respiration, are occasionally present.

Post-mortem Appearances.—The body has a highly offensive odour, and quickly undergoes decomposition. The muscles are

dark, and insensible to the stimulus of galvanism. The large vessels and all the internal viscera are distended with black liquid blood. Sulphuretted hydrogen decomposes the blood colouring matter and forms a greenish compound, with precipitation of albumen and sulphur. It also forms alkaline sulphides with the salts of the plasma. These extreme changes in the blood have not, however, been demonstrated in cases of poisoning by sulphuretted hydrogen.

Treatment.—This consists in prompt removal to a pure air, the use of stimulants, and the respiration of *chlorine* gas as given off from bleaching powder moistened with a dilute acid, or from any of the bleaching liquids. As chlorine is a powerful irritant it should not be administered in too concentrated a form.

Sulphuretted hydrogen rarely exists in a separate state as a poison; but is most commonly met with in union with other gases in privies, cesspools, and common sewers.

Feculent matter in a state of putrefaction gives rise to three principal gases—sulphuretted hydrogen, sulphide of ammonium, and nitrogen. The first two are exceedingly deleterious, the latter possesses negative properties. They exist separately or combined in the soil of privies. Sometimes it happens that no disagreeable odour is given out; neither the nauseous odour of the sulphuretted hydrogen, nor the irritating and pungent odour of the sulphide of ammonium, but still the air is contaminated. In these cases the gases consist of carbonic acid and nitrogen, with a very small proportion of oxygen.

The symptoms and post-mortem appearances caused by the mixed gases do not differ much from those due to the inhalation of sulphuretted hydrogen alone. The rapidity with which the symptoms take place will be proportioned to the degree of concentration of the gas. The most remarkable symptoms produced in those who have been suddenly and strongly affected and subsequently recovered (such as the men employed to empty the common sewers in Paris) are a feeling of violent pressure at the epigastrium, and round the head.

To purify the air as well as to recover persons asphyxiated by these gases, chlorine is the proper agent.

The gases arising from the stagnant water of sewers are similar to those given off by privies and cesspools; but they are partly dissolved by the water. In sewers with a good fall and liberal supply of water no gases are given off; but there is a peculiar animal odour due to their feculent contents. This does not appear to affect the health of the men who work in sewers.

CHAPTER XVI.

VEGETABLE IRRITANTS.

1. Purgatives.—Aloes, colocynth, gamboge, jalap, scammony, seeds of the castor-oil plant, croton oil, elaterium: the hellebores.
2. Abortives.—Savin, and ergot of rye.
3. Irritants, with nervous symptoms.—Œnanthe crocata, cicuta virosa, phellandrium aquaticum, æthusa cynapium, yew, and laburnum.
4. Simple irritants.—Arum, mezereon, ranunculus, bryony (white and black), &c. &c.
5. Diseased and decayed vegetable matters.

I. PURGATIVES.

This group comprises both the more active purgatives now used in medicine, or by the vendors of aperient pills, and the now disused hellebore, which was in earlier times so largely given for the cure of melancholic disorders. Of the purgatives now in use it may suffice to state that, when given in large doses, or to old and infirm persons, they may act as poisons. All those enumerated at the head of the chapter, given alone or in combination, have proved fatal. Their poisonous property resides chiefly in their oily or resinous constituents. Aloes and jalap yield active principles—*aloine* and *jalapine*.

The *Symptoms* produced by this class of poisons are those of irritation of the alimentary canal—vomiting and purging, with pain in the abdomen, cramps, tenesmus, and strangury. The patient falls into a state of collapse, attended sometimes with drowsiness and slight nervous symptoms.

The *Post-mortem Appearances* are those of inflammation of the alimentary canal in various degrees and stages—redness, ulceration, softening, and effusion of dark blood into the submucous tissue.

The *Treatment* consists in the free use of diluents, with opium to relieve pain, and stimulants to counteract collapse.

Some medicines belonging to this group deserve special mention.

ALOES.—This drug owes its importance to the large number of its preparations. The British Pharmacopœia contains no less than ten preparations, and in most quack aperient pills it is a leading ingredient. Mixed with powdered canella, in the proportion of four parts to one, it is the well-known aloetic powder, hiera-picra, or holy bitter. This popular remedy, as well as the quack pills which people are encouraged to take in any quantity, have proved fatal. Aloes yields an active principle (*aloine*), distinguished by giving with cold sulphuric acid a yellow colour, greatly heightened when the solution is warmed, and changing to green when heated. It is also turned orange by nitric acid.

JALAP.—This also is a drastic purgative, which yields an active principle (*jalapine*) characterized by the yellow tint it gives to cold sulphuric acid, heightened to deep orange when warmed and to a red-brown when heated. It is turned yellow by nitric acid.

Fig. 148.

CASTOR-OIL SEEDS.—Of the seeds of the ricinus communis, or castor-oil plant (fig. 148) it will suffice to state that they act on the stomach and intestines with a violence quite disproportioned to the action of the oil which they would yield on compression. Two or three seeds act as a drastic purgative; three seeds have destroyed the life of an adult male in forty-six hours, and twenty seeds that of a young lady in five days, with symptoms of violent irritation of the stomach and bowels, and an appearance as of "one affected with malignant cholera."

CROTON OIL.—The expressed oil of the Croton tiglium (fig. 149) has more than once destroyed life with symptoms of acute irritant poisoning, and collapse resembling that of the worst forms of English and Asiatic cholera. The following is an abstract of a case described by Dr. Greenhow :—

An old lady took by mistake an embrocation containing 30 minims of the oil. When seen two hours afterwards, she had all

the appearance of a person in the cold stage of cholera. There had been profuse purging of matters exactly resembling the rice-water stools of cholera patients, and severe cramps. The surface was cold, the features shrunken, the skin even more blue than is usual in cases of true cholera, the pulse thready and almost imperceptible, and the respiration gasping. She was very restless; but her intellects were unimpaired, and she died in ten hours after taking the poison.*

Fig. 149.

Fig. 150.

Elaterium.—The fruit of the wild or squirting cucumber (fig. 150) yields a juice of such active properties, that the dried sediment or extract of the British Pharmacopœia, is prescribed in a dose of from $\frac{1}{16}$ to $\frac{1}{2}$ grain, while *elaterine*, its active principle, is effective in the small dose of $\frac{1}{96}$ grain. It constitutes about a fourth part of the extract. With cold sulphuric acid, it yields a red-brown solution, deepened in tint by warming, and still more when heated. Nitric acid does not change its colour. Christison quotes from a French authority, the singular case of a medical man in Paris, severely affected with pain and tightness of the head, colic pains, purging, bilious vomiting, and fever, through carrying a specimen of the plant in his hat for twelve hours.

* 'Medical Times and Gazette,' August, 1866, p. 142.

THE HELLEBORES.—The *helleborus orientalis*, or true hellebore, with its black root, or *melampodium*, was largely used by the ancients as an efficient purgative in disorders, bodily and mental, supposed to depend upon black bile.

The *helleborus niger*, or black hellebore, is named like the oriental species, from the dark or black colour of its root; and hence, also, the name "Melampodium" of the old Pharmacopœias. It grows in shady woods, and flowers in January, as the "Christmas rose" (Fig. 151). The leaves and root are poisonous, and the powdered root is a brisk purgative, and, as well as the leaves, a favourite but dangerous worm medicine with the vulgar.

Fig. 151.

The *Symptoms, Post-mortem Appearances*, and *Treatment*, are those proper to irritant poisons generally (p. 379), with violent action on the bowels, and marked symptoms of collapse. A decoction of the root has destroyed life in less than two hours, after producing vomiting, delirium, and convulsions.

The *helleborus fœtidus* (fig. 152), stinking hellebore, bearsfoot or fetter wort, is also a very virulent poison, having a similar action to the preceding, but more powerful. It is known in Westmoreland, where it grows abundantly, as *felon-grass*. It has long been in use as an efficient vermifuge.

II. ABORTIVES.

SAVIN (*Juniperus sabina*).—A small indigenous bushy shrub yielding a round purple fruit about the size of a currant (fig. 153). It has a peculiar strong odour, and an acrid taste; and

owes its irritant properties chiefly to an essential oil readily obtained from the fresh tops of the plant by distillation with water. This oil, and an ointment from the freshly bruised plant, are in the British Pharmacopœia. The dose of the oil is from one to five minims.

The leaves, in powder or infusion, and the oil, are often given to procure abortion; but it is more frequently fatal to the mother than effectual in destroying the child. Savin is also occasionally used as a vermifuge.

Fig. 152.

Symptoms. — Those of irritation of the alimentary canal. Severe pain in the belly and vomiting, and sometimes strangury, but diarrhœa rare. Salivation and insensibility are occasional symptoms.

Post - mortem Appearances. — Those of acute inflammation of the alimentary canal. The green powder is often found among its contents. On drying and rubbing this powder it emits the peculiar odour of the plant, and the hard thick parts of the twigs exhibit, under the microscope, the ordinary characteristics of coniferous wood. Watery solutions of savin strike a deep green with perchloride of iron.

Treatment.—That proper to the whole class of irritants (p. 379).

Ergot of Rye (*Spurred rye, Secale cornutum*).—This is the product of a fungus (*Claviceps purpurea*) attacking the grain of several plants, such as wheat, barley, oats, and rye, in wet seasons, and in ill-drained soils. The ear of the plant is occupied wholly, or in part, by the diseased grains, each of which is of a deep purple

colour, elongated, slightly curved, and projecting, so as to bear some resemblance to a cock's spur. These diseased grains, collected, dried, and powdered, form the ergot of the shops, used by the accoucheur to promote contraction of the uterus, and sometimes criminally given to procure abortion. Fig. 154 shows side by side the healthy (1) and diseased plant (2), an enlarged spikelet (*d*), a section showing the sporidia (*k*), the sporules (*l*), and two entire and full grown samples of the ergot (*g* and *h*).

Properties.—The ergot, when entire, varies in length from a quarter of an inch to two inches, and in thickness from a sixth to a third of an inch. Its surface is black, with lighter dotted

Fig. 153.

Fig. 154.

streaks, and its substance reddish-grey. It is lighter than water, has a disagreeable odour, and somewhat acrid taste. Its activity is ascribed to two substances of the nature of alkaloids, *ergotin* and *ecbolin*. These are brownish amorphous substances soluble in water and alcohol, but not in ether or chloroform. It is questionable how far they are pure substances.

Tests.—*a.* Liq. potassæ gives it a lake-red tint, and develops *trimethylamine* with the odour of herring-brine. *b.* The filtered alkaline liquid has the same colour, and lets fall the same coloured

precipitate, on the addition of nitric acid, or a solution of alum in excess.

Experiments on Animals.—The symptoms produced in animals by large single doses, or by smaller doses frequently repeated, are partly those of intestinal irritation, partly those indicative of affection of the nervous centres. To the first belong diarrhœa, to the last giddiness, dilated pupil, drowsiness, convulsions, and paralysis. Suppurating tumours, and gangrene of the extremities, are also among the symptoms.

In the human subject a single full dose gives rise to irritation of the stomach and bowels, giddiness, headache, and flushing of the face, with great lassitude and weariness. The pulse is diminished in frequency, small and thready. The uterus is excited to contraction, and in a pregnant female abortion may occur. No cases of acute poisoning with ergot are on record.

When the spurred rye, or other grain similarly diseased, is mixed with flour and made into bread, it gives rise, as seen more particularly in former years, to an epidemic malady, which assumes the form either of *convulsive* or of *gangrenous ergotism.* In the first form, nervous symptoms, such as giddiness, weakness of the limbs, mental incapacity, coma, and convulsions predominate; in the latter, dry gangrene of the extremities. Both forms are preceded by symptoms chiefly referable to intestinal irritation.

III. IRRITANTS WITH NERVOUS SYMPTOMS.

This group of poisons may be considered as the unclassed remnant of the large division formerly known as the *narcotico-irritants.* Their very decided action on the stomach and bowels separates them from the group of convulsives of which strychnia is the type, and from that of depressants, of which conium is the best representative.

ŒNANTHE CROCATA

(*Hemlock Water Dropwort*).

This is an indigenous umbelliferous plant, growing on the banks of streams and ditches, and bearing some resemblance to celery (fig. 155). All parts of it are poisonous; but the root, from a rough resemblance to the parsnep, is generally the part eaten by mistake, and is so virulent a poison that a very small piece of it has proved rapidly fatal.

The *Symptoms* may set in as soon as twenty minutes after swallowing the poison, with convulsions and insensibility, livid, bloated face, mouth and nostrils covered with bloody foam, and stertorous respiration; and death may follow in as little as five minutes from the first seizure. In more protracted cases severe nervous symptoms show themselves, consisting of locked jaw, tetanic spasms, and violent mania, or delirium allied to delirium tremens. The pupil is usually dilated. There are symptoms of violent irritation in the alimentary canal.

Fig. 155.

The *Post-mortem Appearances* consist of great congestion of the brain; an accumulation of dark blood in the lungs, heart, and large vessels; and signs of irritation in the stomach and bowels.

The *Treatment* consists in the prompt use of emetics, followed by a full dose of castor oil. Bleeding is indicated by the congested state of the cerebral vessels. The rest of the treatment will be determined by the symptoms actually present.

CICUTA VIROSA (*Water Hemlock, Cowbane*).

This is a perennial, indigenous, umbelliferous plant, growing in wet ditches and on the banks of streams, flowering in July and August. It attains three or four feet in height, has a stunted stem, and large dark green tripartite leaves. The leaflets are grouped in twos or threes, narrowly spear-shaped and serrated; and the leaf-stalks are of a reddish colour where attached to the stem. The flowers are borne on many-rayed umbels. The root stalk, which has been repeatedly mistaken for the parsnep, is hollow and filled with large cells. Fig. 156 shows a cutting of the plant with a flower, and calyx.

The cicuta virosa, has been described as "by far the most active of the poisonous plants of Great Britain;" and reasons have been assigned for the belief that it supplied the "celebrated Athenian poison."*

Fig. 156.

In *animals* the root gives rise to tetanus. In *man* well-marked tetanic spasms are also among the prominent symptoms, together with dilated pupil, insensibility, coma, nausea, vomiting, and diarrhœa. Death may take place within an hour of the swallowing of the poison.

Wepfer gives the cases of two boys and six girls who ate more or less largely of the roots. The boys who took a large quantity were soon seized with acute pain in the stomach, loss of speech, insensibility, and terrible convulsions. The mouth was so closely shut that it could not be opened, blood flowed from the ears, and the eyes were horribly distorted. Death took place in half an hour. The girls suffered from epilepsy.

The cases of three German soldiers related by Boerhaave show that the *Post-mortem Appearances* were well marked. They, too, died in less than half an hour; and the stomach of one was found perforated, the stomachs of the others corroded.

* Stephenson and Churchill's 'Medical Botany,' vol ii. pl. 89.

PHELLANDRIUM AQUATICUM

(*Fine-leaved Water Hemlock*).

This, too, is an indigenous umbelliferous plant, growing in similar situations with the foregoing, and of which the tapering root eaten by mistake for parsneps has produced poisonous effects. The plant grows to about three feet in height, and is furnished with small finely divided dark-green leaves. (Fig. 157).

Fig. 157.

ÆTHUSA CYNAPIUM

(*Fool's Parsley*).

The leaves of this plant, as its name implies, have been eaten by mistake for parsley; and the roots for young turnips. It is an annual umbelliferous plant, growing in gardens and fields, and may be recognized by the secondary involucres appended to the flower-stalks which are composed of three long and narrow drooping leaflets (bracts). When rubbed, the leaves have a nauseous odour. Though it has been said to cause convulsions and stupor in *animals;* and heat of the mouth and throat, nausea and vomiting; headache, giddiness, stupor, dilated pupil, convulsions, and locked jaw in *man,* Dr. Harley has found by careful experiments that it is a harmless plant.*

YEW (*Taxus baccata*).—The leaves and berries of the yew (fig. 159) are poisonous. The leaves have proved fatal to animals, and the leaves and berries to man. The leaves, or an infusion of them, are sometimes given as a vermifuge or abortive.

Symptoms.—Those of irritant poisoning, with the addition of nervous symptoms, such as insensibility, and convulsions. Death

* 'On the Action of Fool's Parsley.' By John Harley, M.D., 1874.

may take place quickly from collapse ; or, at a later period, from inflammation of the alimentary canal. The leaves have killed an adult in 14 hours, and the berries a girl of 5 years old in 4 hours.

Fig. 158.

Post - mortem Appearances. — Those of irritation of the alimentary canal. The leaves or berries are generally found in the stomach, and are readily identified. The leaves are lancet-shaped ; and the berries, the size of a pea, consist of a hard brown, egg-shaped seed, enclosed in a light red covering, and surrounded by a colourless viscid juice, which has an acid reaction and a nauseous taste.

Laburnum (*Cytisus laburnum*). — All parts of this plant appear to be poisonous, and cases are on record of poisoning by the seeds, flowers, and bark. The plant has a most nauseous and disagreeable odour and taste. It owes its poisonous properties to an alkaloid known as *cytisin*. According to Masmé, ·03–·04 gramme of this alkaloid is a fatal dose to a cat. From Christison's experiments with the dried bark, it may be inferred that the laburnum is extremely active, producing in a few minutes violent tetanic convulsions and speedy death. In man, too, the symptoms are very well marked, consisting of violent irritation of the alimentary canal, with great exhaustion, drowsiness, and rigidity of the limbs, convulsions, dilated pupil, and frequent pulse.

But two cases of poisoning by the bark eaten by a girl of ten,

and a boy of eight, in mistake for liquorice, reported by Mr. Sedgwick, of Boroughbridge, show that the laburnum does not always produce the symptoms just enumerated. They were such as to qualify the plant for a place among depressants rather than convulsives. The symptoms of depression preceded the administration of tartar emetic as a vomit. In the boy, the symptoms set in an hour and a quarter after eating a piece of the root the size of a walnut; in the girl, who had eaten about three times as much, they began after about the same interval. In both, the first symptoms were vomiting, giddiness, extreme weakness, pallor and coldness of the skin, and a feeble fluttering pulse. The pupil was dilated. Drowsiness showed itself later; but there was at no time any marked pain of the abdomen, nor any purging. Besides the drowsiness there were no head symptoms.*

Fig. 159.

IV. SIMPLE IRRITANTS.

ARUM (*Arum maculatum, lords and ladies, cuckoo pint*).—The green spotted arrow-shaped leaves (1) of this plant appear early in spring in hedgerows, woods, and shaded spots; the green spathe (2), with its purple column (3) enclosed, in May; and a cluster of bright red berries (4) alone, towards the end of summer. The root is tuberous and somewhat heart-shaped, and, like all other parts of the plant, is highly acrid and irritating. The juice applied to the tongue causes acute darting pain, as if it were pierced with sharp needles; and in three children who ate of the leaves of the plant, the tongues were so swollen as to render swallowing difficult. Two of the children died in twelve and sixteen days respectively; the third recovered. The poisonous properties of the plant are wholly dissipated by heat; and the roots, first steeped in water, and then baked and powdered, constitute the "*Portland sago.*" The *Symptoms,*

* 'Medical Times and Gazette,' Jan. 3, 1857. See also similar cases by Wheelhouse ('Brit. Med. Journ.' 1870, No. 473), and Tinley ('Lancet,' 1870. vol. ii. 6).

Post-mortem Appearances, and *Treatment* are those proper to irritant poisoning (p. 379).

Fig. 160.

1. 2. 3. 4.

MEZEREON (*Daphne mezereum*).—This is a cultivated garden shrub yielding bright red berries, apt to attract the notice of children, and to be mistaken for currants (fig. 161). They contain a single ovate seed, composed of two plano-convex cotyledons enclosed within the coat. The plant has highly irritating properties. Five or six of the berries are sufficient to produce serious effects. The bark is an ingredient in the compound decoction of sarsaparilla of the British Pharmacopœia, and is the basis of the ethereal extract of mezereon. The *Symptoms, Post-mortem Appearances,* and *Treatment,* are those of irritant poisoning (p. 379).

Fig. 161.

RANUNCULUS (*Crowfoot, buttercup*). —There are no less than fifteen species of ranunculus, or crowfoot, natives of these islands, and common in our meadows and pastures, and most

Fig. 162.

of them have more or less irritating properties. Those which are esteemed most poisonous are the Ranunculus flammula, bulbosus, and sceleratus; the R. acris and arvensis being less deleterious. Fig.162 shows a plant of the Ranunculus acris. Every part of the fresh plant is pervaded by an acrid principle, which like that of Arum maculatum, is volatile, and dissipated by heat, or when the plants are dried. Water distilled from the fresh plants contains the acrid principle, as is shown by the stinging taste, and sense of heat in the stomach. The distilled water of the R. *sceleratus* yields crystals. The juice of the plants is a powerful vesicant, and prior to the introduction of cantharides was used by medical men for this purpose. It is now so used to produce ulcers on the legs by mendicants and malingerers. The distilled water of the R. *flammula* is an effectual and speedy emetic; and was greatly commended by Withering as preferable to any other when the object is to produce a quick evacuation of the stomach. The bruised leaves, too, are used as vesicants.

The *Symptoms, Post-mortem Appearances*, and *Treatment* of poisoning by the ranunculi are those of irritant poisoning (p. 379).

Bryony.—The two plants which bear the common name of bryony have a certain importance as poisons, partly on account of their strong irritant action, and partly from their common presence in our woods and hedgerows. Though they bear the same English name, they do not even belong to the same natural order, the white bryony being the solitary representative among our common wild plants of the Cucurbitaceæ, while the black bryony belongs to the Diascoriaceæ.

The *White Bryony* (Bryonia dioica, or wild vine) is very common in our woods and hedges, twining among trees and bushes, and clinging by its tendrils. The leaves are rough, the flowers small and of a faint green colour; the berries clustered, and, when ripe, red, filled with a fœtid unpleasant juice, and containing six seeds; and the root, spindle-shaped, fleshy, and pale in colour, often attains a considerable size and thickness.

Fig. 163 shows a cutting of the plant, with a small cluster of berries.

Fig. 163.

The root of this plant was formerly in use as a medicine, and was known to occasion vomiting and purging, with symptoms of collapse, sometimes ending fatally. The berries, when eaten by children, have caused vomiting,

The *Black Bryony* (Tamus communis) is also very common in woods and hedges, twining, without the aid of tendrils, and contrasting strongly with the white bryony in its leaves, which are heart-shaped, pointed, smooth, and shining; in its berries, which are ovoid; and in the colour of its root, which is black. The berries are in clusters, and, when ripe, are like those of the white bryony, of a red colour. A cutting of the plant, with a cluster of berries, is shown in fig. 164. The root of this plant has also been used as a cathartic, and the berries have made children sick.

Fig 164.

Besides the vegetable irritants briefly noticed in this chapter, there are others of less importance, of which it must suffice to append a list. Some of them have produced the effects of irritants in the human subject, and have proved fatal, while others are inferred to be poisonous from their effect upon animals, or from direct experiment. A minute description of these poisons and of their effects must be sought for in works on

Toxicology. Most of them will be found figured, with brief descriptions of their effects, in Johnson's 'British Poisonous Plants.'

Fig. 165.

The following is the list in question:—Anemone pulsatilla, or pasque flower (also the A. nemorosa, A. hortensis, and A. coronaria, with other species); Caltha palustris, or marsh marigold; Chelidonium majus, or celandine; Daphne laureola, or spurge laurel; Euphorbia lathyris, or caper spurge (also other species, as the E. officinarum, fig. 165), peplus, and helioscopia; Gratiola officinalis; Hyacinthus nonscriptus, or wild hyacinth; Mercurialis perennis, or herb mercury; Narcissus poeticus, and N. pseudonarcissus or daffodil; Rhus radicans, and toxicodendron; Paris quadrifolia (fig. 166), Sedum acre; Delphinium staphysagria, or stavesacre (interesting as yielding the alkaloid *delphinia*); and the Sambucus nigra, or elder, the leaves and flowers of which, in Christison's experience, caused dangerous inflammation of the mucous membrane of the bowels, lasting for eight days. Two tablespoonfuls of the root of the Dwarf Elder (S. *edulus*) have also proved fatal to a woman fifty-four years of age.

Fig. 166.

A

Besides the foregoing, which are indigenous plants, the Jatropha curcas, or physic nut of the West Indies; and the Hippomane mancinella, or manchineel, with other species of the same (as the H. figlandulosa, and H. spinosa), may be mentioned as possessed of highly irritating properties. (See Christison, chapter on Vegetable Acrids.)

Most of the plants in the foregoing list act as simple irritants; but there are a few, such as the Mercurialis perennis, and Paris quadrifolia (fig. 166), which produce mixed symptoms of intestinal irritation and narcotic poisoning; and would, therefore,

claim to be placed among the narcotico-acrid poisons of the earlier toxicologists.

V. DISEASED AND DECAYED VEGETABLE MATTERS.

A few cases have occurred of poisoning by spoiled vegetables; and bread made of wheat, rye, or barley, when spoiled or mouldy, has been known to act as an irritant poison, causing flushed face, dry tongue, acute colic pains, urgent thirst and headache, vomiting and purging, exhaustion and drowsiness.

The *Treatment* proper to such forms of poisoning consists in the prompt use of emetics, followed by aperients, of which castor oil is the best.

CHAPTER XVII.

ANIMAL IRRITANTS.

I. CANTHARIDES.

II. DISEASED AND PUTRID ANIMAL MATTER.

III. TRICHINIASIS.

IV. POISONOUS FISH. V. VENOMOUS REPTILES AND INSECTS.

I. CANTHARIDES.

THE Cantharis vesicatoria, Spanish fly, or blister beetle, is distinguished by the shining metallic green colour of the head, legs, and wing-cases. It contains a strong irritant poison, characterized by its energetic action on the urinary and generative organs, and is the active ingredient of several preparations of the British Pharmacopœia. The powder and tincture have been given to procure abortion, for lascivious purposes, or merely for a joke; and both powder, and plaster have been taken by mistake. Its preparations have also produced severe effects on the urinary and genital organs when applied externally. The fly owes its poisonous property to an active crystalline principle *cantharidine*, of which half an ounce of the powder contains one grain, and the hundredth part of a grain will raise a blister on the lips.

The powder and plaster are readily identified by the small shining golden or green particles; and the powder by the simple test of heat. If so small a quantity as the hundredth part of a grain be treated in the manner described at p. 443 (fig. 65), as soon as the temperature is raised to about 212° Fahr., a white sublimate appears on the glass disk; and this, when examined under the microscope, is found to consist of crystals of cantharidine. If, however, the sublimate should be amorphous or indistinctly crystalline, the characteristic crystals may be made to appear by treating the spot with ether. The characteristic

* Of the tincture, containing grs. vss to the ounce; of the acetum (℥ij to Oj); of the ointment (1 to 7); of the plaster (1 in 3); of the emplastrum calefaciens (1 in 24); of the liquor epispasticus (℥ij to ℥v); and of the charta epispastica (1 in 10½). The tincture is given internally in doses of 5 to 20 minims, the other preparations are for external use.

sublimate may be procured from the five hundredth, or even the thousandth of a grain. The low subliming temperature, absence of colour, and more or less distinctly crystalline form of the sublimate, taken together, are strikingly characteristic of this powder.

Symptoms.—Soon after swallowing the poison there is a burning sensation in the mouth and throat, quickly followed by a like sensation in the pit of the stomach, increased by pressure, extending at length over the whole abdomen, and accompanied by excessive pain in swallowing, dryness of the fauces, great thirst, copious discharge of blood or bloody mucus from the stomach, mixed with shining green particles, and, in less quantity, from the bowels; tenesmus, pain in the loins, distressing strangury, bloody stools and urine, and priapism, with swelling and inflammation of the genital organs. The patient is extremely restless, the breathing laborious, and the pulse quick and hard. Sometimes headache, delirium, and convulsions, tetanic spasms, symptoms allied to those of hydrophobia, and coma are superadded.

Among the occasional symptoms are blisters of the mouth, salivation, vomiting of tenacious mucus of the shape of the gullet, or of the mucous membrane itself, redness of the eyes, and lachrymation; and albuminous urine.

The tincture, in small doses of four or five drops, produces a marked effect on the urinary organs, curing incontinence of urine, sometimes without causing pain. On the other hand, very large quantities, as six ounces of the tincture, or two drachms of the powder, have been taken without bad effect, a fact only to be accounted for by the badness of the preparation.

Fatal Dose.—Of the tincture, one ounce; of the powder, not ascertained. Two doses of twenty-four grains each, taken at an interval of a day, have destroyed life, after producing abortion.

Fatal Period.—Usually from twenty-four to thirty-six hours, but it may be fatal after some days of suffering.

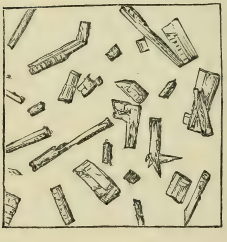
Post-mortem Appearances.—Marks of inflammation in different degrees and stages in the whole length of the alimentary canal, and in the urinary and genital organs. The stomach is inflamed, and may be gangrenous, in patches, where the powder has adhered; sometimes it is abraded, sometimes softened. The brain has been found gorged with blood, and the genital organs gangrenous. The powder may be found in the stomach long after death. When given in powder, or taken as plaster, the blistering fly may be detected in the contents of the stomach by the glistening golden or green colour of the particles, which may be readily seen by the lens or microscope. They may be collected, dissolved in ether or chloroform, evaporated to the thickness of

an extract, and its blistering property tested by application to the lip. By these two tests Barruel detected cantharides in some cakes of chocolate maliciously given to several persons. The sublimation by heat is still more satisfactory.

When the stomach has been discharged by vomiting, or the bowels emptied by aperients, the poison may still adhere to the coats of the canal. In this case we follow the plan recommended by Poumet.* The intestinal canal having been detached, is inflated and dried; and portions of it are placed on sheets of glass, and carefully examined for the shining green spots. M. Poumet has detected them seven months after interment.

Treatment.—There is obviously no antidote to this poison. Vomiting is to be excited and encouraged by emetics and warm liquids; and the poison to be removed from the bowels by full doses of castor oil. The free use of diluents, with oily or demulcent injections into the rectum and bladder, and leeches or bleeding, if the inflammatory symptoms run high, constitute the remainder of the treatment. Laudanum may be added to the injections, or opium suppositories introduced into the rectum.

Fig. 167.



Cantharidine.—This is sold in the form of sparkling colourless crystals, which, when examined by the microscope, are found to consist of plates of various forms, lengths and thickness.

Fig. 167 is taken from a good commercial specimen. It retains similar forms, but more delicate, and with some variety of grouping, in deposits from its solutions in ether and chloroform, and in its sublimates. The deposits from ether are commonly long quadrangular plates, those from chloroform square plates and shorter oblongs. Fig. 168 shows the two forms most common in the sublimates—namely, the short plates (*a*) and the long plates (*b*). It is taken from photographs.

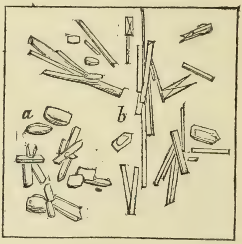
Cantharidine, when heated in the manner described at p. 443 (fig. 65), sublimes without residue, or leaving a faint stain only, and settles on the glass disk in such forms as those shown in fig. 168. It may be wholly dissipated without liquefying; but if the heat be applied suddenly it melts. Its subliming point is 212° Fahr.

* 'Annales d'Hygiène,' 1842, p. 347.

Cantharidine is almost insoluble in water, but readily soluble in ether, and more so in chloroform. It is also soluble in oils. Towards soda and potash it behaves like an acid and forms salts. These are precipitated by chloride of calcium and chloride of barium, white; chloride of mercury and nitrate of silver, white and crystalline; and by sulphate of copper, grey. Ether, benzine, amylic alcohol and chloroform extract cantharidine from acid solutions.

The action on cantharidine of sulphuric acid distinguishes it from almost all the active principles of vegetable origin. The acid produces no change of colour in it even when warmed and heated. Nor is its colour changed by nitric acid. These two negative reactions, taken together, distinguish cantharidine from every poisonous alkaloid or analogous active principle.

Fig. 168.



× 50.

Cantharidine also differs from the vegetable alkaloids and glucosides in leaving no deposit of carbon when heated; and in the temperature at which it sublimes, it differs from the mineral poisons, arsenious acid, and corrosive sublimate.

The physiological test of cantharidine is its vesicating property, which is manifested by such a minute quantity as ·00014 gramme. Some animals—especially common fowls—are not affected by cantharidine, though their flesh given to cats causes all the symptoms of poisoning by cantharides.

II. DISEASED AND PUTRID ANIMAL MATTER.

There is a disease prevalent among cattle in some parts of the Continent, but less known in England, which consists in the formation of large boils upon different parts of the body. The flesh of animals dead of this disease has often produced severe effects by contact with the skin, and, when eaten, has destroyed life either by producing violent cholera, or by creating a similar disease to that under which the animal laboured. The glanders communicated to man from the horse, and the diffuse inflammation excited by punctured wounds inflicted in dissection, or in preparing meat

for the table, are familiar examples of the effect of diseased animal matter applied externally.

Putrid Animal Matter may cause severe and dangerous symptoms of irritant poisoning. The articles of food which have most frequently acted as poisons are sausages (especially those made of liver and blood), bacon and ham, cheese, and goose grease. The poisonous quality of the food appears to be developed only in the first stages of putrefaction.

The *Symptoms* rarely come on till the lapse of three or four hours. The irritation of the alimentary canal is accompanied either by symptoms of collapse or of narcotism.

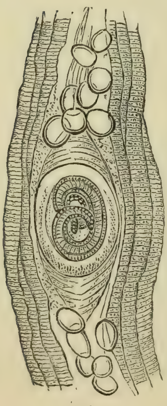
The milk of cattle fed in pastures containing poisonous plants, the flesh of game which has fed on certain berries, and the honey of bees collected from poisonous flowers, produce delirium and symptoms of narcotic poisoning.

The *Treatment* of these cases, after the removal of the poison from the stomach, would be determined by the nature of the symptoms present.

III. TRICHINIASIS.

A very formidable malady in man and the domestic animals, is due to the reception into the stomach of the ova of the entozoon known as the *Trichina spiralis*. The vehicle by which they are conveyed into the stomach is the raw or imperfectly-cooked flesh of pork, whole or made into sausages. The disease is most frequent in Germany, but several cases l ave occurred in England. In Germany it has more than once appeared as an epidemic; and in Hetttsädt, in Prussia, no less than eighty persons in a population of about 5500 were attacked by the disease through eating badly-cooked sausages, made from meat infected with the parasite. Eighteen or twenty persons had died before the subject became properly understood. The disease is so common in Germany that Dr. Zenker, of Dresden, found trichinæ in as many as one body in every thirty-four inspected by him.

Fig. 169.

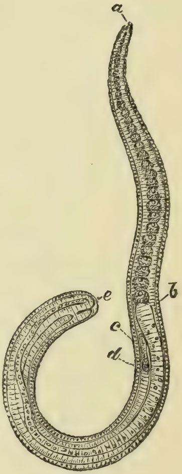


× 50.

The trichinæ begin to be developed very soon after they are swallowed; males, females, and embryos in very large numbers

being produced in the intestinal canal, and thence finding their way into the muscles, where they become encysted and inert. They are seen in the muscles, between the bundles of fibres, as opaque white specks. Fig. 169 shows the trichina coiled up within its cyst, with groups of fatty cells at either end; while fig. 170 exhibits it removed from its cyst. In this figure *a* represents the mouth, *b* the commencement of the alimentary canal, *c* and *d* a tubular sac, with dark granular body, extending to the anal extremity at *e*.*

Fig. 170.



Symptoms.—In many cases the disease sets in with diarrhœa. There are extreme weariness and depression, loss of appetite, sleeplessness, febrile symptoms, severe pains in the muscles, with sometimes œdematous swellings of the joints, followed occasionally by painful persistent contractions of the flexors of the limbs. In some instances, typhous symptoms come on, and the patient dies unconscious; but the more common termination is by pneumonia. In fatal cases death occurs within a month of the ingestion of the food containing the parasite.

Post-mortem Appearances.—The muscles are found of a pale reddish-grey colour speckled with small lighter coloured spots, which are the trichinæ in all stages of growth. They are found in all the voluntary muscles, and in the heart.

Treatment.—There is no remedy for the disease. The existence of trichinæ should inspire caution in selecting pork for food, and in rejecting pork and sausages which have not been properly cooked.

IV. POISONOUS FISH.

Some fish are constantly poisonous, others only occasionally so, and others again, or parts of them, act injuriously on certain persons only. The most important of these is the common *mussel*, which becomes poisonous in certain circumstances not yet well understood.

The symptoms generally show themselves after one or two hours with swelling and itching of the eyelids, and watering of

* See Griffith and Henfrey's 'Micrographic Dictionary,' art. Trichina.

the eyes, and an eruption on the skin, in most cases closely resembling common nettle-rash, and attended with intense heat and itching. Dyspnœa generally follows, but occasionally precedes, these symptoms; there is extreme weakness; and in fatal cases delirium, convulsions, and coma have supervened. *Symptoms* of irritation of the stomach are not always present, but in some instances there have been nausea, pain in the pit of the stomach, vomiting, and difficulty in swallowing.

The *Treatment* consists in the free use of emetics, purgatives, and diluents. Ether may be given with advantage.

Instances are on record in which oysters, eels, and salmon have produced injurious effects. The richer fish also habitually disagree with some persons.

V. VENOMOUS REPTILES AND INSECTS.

As no difficult medico-legal questions arise out of the poisonous effects produced by the insertion of the various secretions of animals into wounds, whether inflicted by the fangs of serpents, the stings of insects, or the claws of such creatures as the ornithorhynchus, or (as in the case of the cutaneous secretion of the common toad) inoculated for the purpose of experiments, this subject will be very briefly noticed.

In England we have but one venomous snake, the common viper, or adder (Vipera berus). It is about two feet long, has a brown body, slate coloured belly, rhomboidal dorsal scales, with a row of black spots on each side, head covered with rough scales, and poisonous fangs in the upper jaw. It appears, however, that the colour is not always the same; for Dr. Stephenson ('Medical Zoology and Mineralogy,' p. 66) figures two adders found near Harrow-on-the-hill, the one brown, the other blue-black.

The *Symptoms* caused by the bite of the adder are sharp pain in the wound, swelling, redness passing into a livid hue, and rapidly extending to adjoining parts. Blisters form round the wound, like those of a burn. The pain soon abates, the parts affected become œdematous and livid, and large livid spots appear on the surface. The general symptoms, which commonly show themselves within forty minutes of the bite, consist of anxiety, prostration, cold sweats, and feeling of giddiness and faintness; bilious vomiting and diarrhœa; quick, small, and irregular pulse, and difficult breathing; to which are sometimes added convulsions, and disturbance of the mind.

The *Treatment* consists in the immediate application of a ligature between the wound and the heart, and the removal of the

poison by suction. Ammonia should be applied to the wound and given internally. Tincture of iodine, or iodine paint, is a useful application to the stings of venomous insects, and might be applied with advantage to the wound of the viper.

The venom of the *cobra di capello* surpasses that of all other snakes in virulence. The local symptoms are of a similar character to those above described, but more intense, the bitten part seeming to undergo rapid decomposition. The constitutional effects manifest themselves by depression, nausea, faintness, and vomiting. Paralysis ensues, and before death, which is generally preceded by convulsions, there are involuntary discharges of a sanguineous character.

Drs. Brunton and Fayrer have proved that the poison paralyses the spinal cord, motor nerves, and muscles. Death is usually the result of the paralysis of the muscles of respiration, and if artificial respiration be kept up, the heart may continue to beat many hours after the apparent death of the animal. No case of complete recovery has, however, resulted from this method of treatment.

The injection of ammonia into the veins, which has been much praised by Halford as a successful antidote to snake-bites, was long ago tried by Fontana without success, but the recent investigations of Brunton and Fayrer do not establish the reputed efficacy of this method of treatment. The internal administration of ammonia and brandy has sometimes been found to be followed by good results.

For an account of the effects of snake-bites see Fayrer's 'Thanatophidia of India,' and a Paper by Brunton and Fayrer in the 'Proceedings of the Royal Soc.,' No. 149, 1874.

APPENDIX.

ON THE DETECTION AND IDENTIFICATION OF MINUTE QUANTITIES OF POISON,

By the Method of Sublimation, and by Tests applied under the Microscope; with a Description of the Crystalline Forms of the Principal Poisons, Inorganic and Organic.

When the detection and identification of such minute quantities of poison as the thousandth, ten thousandth, hundred thousandth, or even millionth of a grain are spoken of, inexperienced persons are apt to be incredulous through misapprehension of the bulk of matter which a grain represents.

One way to correct this misconception is to count the number of distinct visible particles of certain common objects, such as seeds. Those of digitalis, for instance, number 1126 to the grain, and those of lobelia inflata 3,176, while the fern seeds of the shops can be counted to the number of 50,900. By successive divisions and subdivisions of a grain of strychnia, strewn on a surface of black glass, the $\frac{1}{100000}$th of a grain becomes visible as a bright speck by the naked eye. Again, crystals of arsenious acid, weighing the $\frac{1}{25000000000}$th of a grain, may be recognised under the microscope.* When, therefore, we speak of the thousandth, five thousandth, or ten thousandth, of a grain of arsenic, we are still speaking of visible particles. And when we speak of metallic crusts obtained by Marsh's apparatus, from the half millionth or millionth of a grain of arsenic, we have only to revert to the fact that a single grain of gold can be mechanically divided into 490,000 visible pieces, and into the almost incredible number of 4 900 000,000 fragments visible by the microscope. Of the recognition of minute quantities of matter by other senses, we have

* Beale's 'Archives of Medicine,' No. iii. 1858

examples in the distinct impression on the sense of smell caused by $\frac{1}{30000}$th of sulphuretted hydrogen, $\frac{1}{40000}$th of bromine, $\frac{1}{1300000}$th of oil of resin, and a still less quantity of musk.

Of the methods of detecting such minute quantities of poison, some are of partial application (Marsh's apparatus to arsenic and antimony; Reinsch's method chiefly to arsenic, mercury, and antimony; the reduction by zinc mainly to lead, tin, and silver; the blowpipe, and borax bead to metals and their salts), others of more extended use. Of these the *method of sublimation on to flat surfaces; that of liquid reaction on dry spots; that of liquid reactions under the microscope;* and *minute crystalline forms;* will be here described in the order in which they stand.

1. *Sublimation on to flat surfaces.*—The test-tube heated by the spirit-lamp has always been largely used in testing for poisons. But this is a coarse method, scarcely applicable to the identification of those minute quantities of poison which require the supplemental aid of the microscope. Accordingly I recommended some years since* for arsenic, corrosive sublimate, and other inorganic poisons, a method of sublimation on to flat surfaces, which gave very satisfactory results, especially when submitted to examination by the microscope. This method acquired a new and increased importance from the interesting discovery of Dr. Helwig, of Mayence,† that the alkaloids, when sublimed in this manner, also yield sublimates, some of which have highly characteristic forms and reactions. While engaged in verifying the statements of Helwig, I saw reason to modify his method, and to extend it to a much larger class of objects (G.). ‡

The simplest form of sublimation is with the spirit-lamp and platinum foil. It deals with small quantities of matter, and affords many useful indications. Some poisons, as arsenious acid, corrosive sublimate, oxalic acid, and cantharidine, are sublimed without residue; others, such as the alkaloids, change colour, melt, and deposit carbon, and some others undergo no characteristic change. The method of sublimation by the spirit-lamp and test-tube has the two-fold advantage of exhibiting the changes caused by heat in the poison itself, and, in such cases as arsenious acid, corrosive sublimate, and the metals arsenic and mercury, displaying the characters of the sublimates deposited on the higher part of the tube. That this method is wanting in delicacy, and presents its results in a form unfavourable for examination by lens and microscope, has been pointed out in the text at p. 441, in treating of the sublimation of arsenic; where a better method by which the direct effect of heat is also shown, but the sublimate,

* Beale's 'Archives,' No. iii. 1858.

† 'Das Mikroskop in der Toxikologie,' 1865.

‡ See 'Pharmaceutical Journal,' June to October, 1867; and 'Journal of the Royal Microscopical Society,' January, 1868.

if any, received on a flat surface of glass, is described and figured (fig. 60).

But this method, though an obvious improvement on the test-tube, is open to the objection that a part of the sublimate will settle on the sides of the specimen-tube, whereas, especially in dealing with minute quantities of poison, it is important to obtain a succession of sublimates on surfaces of glass, both for microscopic examination, and for the application of tests, under the microscope. For this purpose it is necessary to create a shallow cell, from the heated floor of which the products, as they arise, may settle directly on the flat roof of glass. This form of apparatus (similar to the one with which Helwig made his discovery) is also described and figured in the text (in the chapter on Arsenic) fig. 65, p. 443.

When this simple operation is carefully performed, no part of the sublimate escapes, and a series of deposits may be obtained from mere specks of the substance under examination. The ten-thousandth of a grain of strychnia, and less than the hundredth part of a grain of the powder of cantharides, will yield characteristic sublimates. It is obvious that this method combines the advantage of the platinum-foil with that of the reduction-tube; for the white porcelain seen through the glass slide shows clearly the direct effect of heat, whilst the slide carries the sublimates in a form perfectly adapted to microscopic examination and the use of reagents.

The diagnostic value of this method both for inorganic and organic poisons may be enhanced by a simple arrangement for noting the temperature at which changes of form and colour, and sublimation itself occur. This may be done by substituting for the porcelain slab a disk of copper with a hollow nipple made to receive a thermometer indicating degrees of heat up to 600° Fahr. or more. The substance to be examined is placed on a fragment of microscopic glass converted into a shallow cell by a glass ring cut from a tube and a disk of miscroscopic glass resting on the ring. The cell being placed on a copper disk, the flame of the spirit-lamp is steadily applied to the under surface of the copper at a point equidistant from the substance itself and the thermometer. This arrangement will be readily understood by reference to figure (171, p. 668).

The following are examples of the application of this method to some of the most active poisons in such small quantities as the hundredth of a grain or less, supposed to be reduced to powder:—

a. Corrosive sublimate, no change of form or colour, sublimes at 200°; melts at a higher temperature. *Cantharidine*, no change of form or colour, sublimes at 212°; melts at a higher temperature. *Calomel*, no change of form or colour, sublimes at 240°. *Arsenious acid*, no change of form or colour, sublimes at 280°. Corrosive sublimate, cantharidine, and arsenious acid yield crystalline sublimates, consisting respectively of groups of needles, groups of

plates and prisms, and octahedra. The sublimate from calomel is amorphous.

b. Tartar Emetic decrepitates at 380°, sublimes slowly and scantily at 480°, and chars at about 550°.

c. Strychnia.—No change of form or colour till sublimation at 345°; at 430° melts, darkens, and deposits carbon, still yielding sublimates. *Morphia*, no change of form or colour till 330°, when it sublimes, melts at 340°, darkens and deposits carbon, still yielding sublimates.

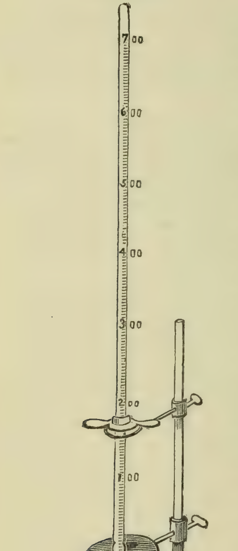
The method of sublimation conducted as just described, with or without the thermometer, is applicable to the following distinct purposes:—The direct sublimation of white powders or colourless crystals; the sublimation of deposits from solutions; the separation of active volatile poisonous principles from powders which contain them as constituents or admixtures. The following are illustrations:—Take a crystalline speck of strychnia. It will yield a distinct white sublimate. Take such a quantity as the $\frac{1}{100}$th grain. It will yield several successive sublimates before and after melting. From the thickest of these proceed to obtain secondary sublimates. Dissolve a grain of arsenious acid in an ounce of distilled water; evaporate a drop on a slab of porcelain and sublime the dry residue. Take the $\frac{1}{100}$th grain of powdered cantharides. It will yield a well-marked sublimate, rendered very distinct if moistened with a drop of ether. Take a drop of the liquid used for browning gun-barrels, which consists of corrosive sublimate, muriate of iron, a salt of copper, and spirits of wine: evaporate it to dryness. It is crystalline, as seen under the microscope. Sublime off the corrosive sublimate, leaving the salts of copper and iron behind. Identify the corrosive sublimate by its crystalline form, and by its reactions with minimum drops of liquor potassæ, and iodide of potassium. Then dissolve the salt of copper with liquor ammoniæ, yielding the characteristic blue solution. Wash with distilled water, and dry; and identify the salt of iron by the Prussian-blue test.*

2. *Liquid Reactions on Dry Spots.*—The dry spots obtained by sublimation and by deposit from solutions, often consist of well-defined and highly characteristic crystals. But these crystalline forms may be common to more than one sublimate or deposit, or they may be imperfectly developed, or perhaps replaced by amorphous forms. And here liquid reagents may be used with great advantage; and, as the constituents of the dry spot, even when very minute, are in a state of concentration, the results

* It will be observed that the apparatus now recommended for determining the temperatures at which poisons sublime, though available for diagnosis where the differences of temperature are considerable, is one that can lay no claim to delicacy or minute accuracy. A more accurate and delicate method, with some of its results, is described by Mr. Wynter Blythe in the 'Journal of the Chemical Society,' August, 1878.

are highly satisfactory. When, for instance, the sublimates of strychnia and corrosive sublimate do not happen to contain characteristic crystalline forms, their true character is at once determined by the addition of the smallest drop of their appropriate reagents; and with proper care there is nothing to prevent the application to the same spot of all the reagents that have been found to give characteristic results. For the application of these minute quantities of liquid, the pipette and spatula, figured at p. 399 of the text, may be recommended. The smallest visible speck of liquid may be taken from the drip of a pipette with the fine point of the spatula, and applied to any part of the sublimate or deposit. A fine platinum wire fixed in a handle, and a forceps with curved platinum ends complete the instruments needful for these delicate testings.

Fig. 171.



The colour-tests for strychnia afford striking illustrations of the delicacy and certainty of this method. A dry sublimate of strychnia, or a dry deposit from a solution containing the alkaloid, being placed under the microscope, a droplet of sulphuric acid, with a speck of the colour-producing reagent (bichromate of potash, ferridcyanide of potassium, permanganate of potash, peroxide of manganese, and peroxide of lead) is to be placed at the margin of the crust. The sulphuric acid is first brought in contact with the crust, and then the colour-developing reagent. With whatever part of the margin of the crust the acid is brought into contact, followed by the colour-developing reagent, the rich blue tint, passing to mulberry and light red, will be developed. In no way do the colour tests for strychnia act so characteristically.

Liquid Reactions under the Microscope.—This method consists in the application to so small a quantity as a drop of some liquid supposed to contain a poison, of liquid reagents in quantity still

more minute. It is one that presupposes delicacy of manipulation, scrupulous cleanliness, and the use of reagents so preserved and applied as to be free from impurity. To fulfil these conditions, the drop bottle and spatula just referred to as being figured at p. 399 of the text were devised. The drop-bottle contains a pipette which dips into its liquid contents. It is drawn to a fine point at the lower end and sealed at the upper, and is ground to fit the neck of the bottle like a stopper. When withdrawn, a drop of the liquid falls from it, and the warmth of the hand expels its contents guttatim. When only small quantities of the reagent are required, the tube may be used both as bottle and pipette. The sealed end may be warmed by the spirit-lamp and the open end immersed in the liquid, which will flow into it as the glass cools. The spatula, consisting of a triangular piece of window-glass ground at the edges, thinned at the point, and inserted in a wooden handle, answers more than one useful purpose. The smallest fraction of a drop of liquid may be taken up from the drip of the pipette, and the sides may be used to crush small crystals; to draw from the surface of a liquid containing sediment a portion of clear liquid; and to make extempore solutions in a watch-glass, or on a slide. A drop of the liquid supposed to contain poison is to be placed on a glass slide and carefully examined: the reagent is then to be added without disturbing the slide, and the immediate effect observed, as well as those changes which take place more slowly; and lastly, the liquid having been allowed to dry under cover, is again submitted to examination. The reactions thus produced may take place instantaneously, quickly or slowly, and they may show themselves on the surface of the glass or liquid, or in the body of the liquid itself. If crystals are formed they may float, lie flat on the glass, or stand up in the fluid as corn on the ground. In the dry spots, also, they may be found on the glass, or projecting from it. It is this variety of place and position that renders the binocular microscope so important, and even essential; for it is no exaggeration to say that a microscopic crystal is not fully seen till it is viewed by this instrument, and that by this instrument only can we see the dry result of a sublimation or reaction in full relief, or appreciate all the changes that take place on the surface as well as in the depths of the liquid. As room is required for manipulation, and as good light and clear definition are far more important than mere enlargement, a good inch object-glass, with a deep eye-piece, will be found to meet all the requirements of the great majority of cases; and this we accordingly recommend with the confidence arising out of a very large experience (G.). The combination of an inch object-glass, with a No. 1 eye-piece of our best makers, gives a magnifying power of 50 diameters.

In using reagents which consist of saline solutions, two precautions should never be neglected. The solution should be of

a defined strength, and the form of the crystals it leaves on evaporation should be previously ascertained; for these crystals, with very rare exceptions, will be found forming part of the dried spot. For most test-solutions 1 part by weight in 100 is a suitable strength. In some cases, perhaps, it may be well to cover the drop of liquid with a disk of thin glass, and to apply the reagent to the margin.

4. *Minute Crystalline Forms.*—Crystals play a very important part in the detection and identification of minute quantities of poison, whether they are obtained by sublimation, by deposit from solution, by reaction of liquid with liquid, or of liquid with dry spot. Now, crystalline forms, however obtained, are subject to modifications, with the nature and causes of which we ought to be acquainted. Fortunately, the crystals most interesting to the toxicologist are few in number; the most important being the octahedron (the typical form of arsenious acid), the tetrahedron (one of the two forms obtained from solutions of tartar emetic), prisms, six-sided (morphia), four-sided (strychnia and oxalic acid), plates (cantharidine), and needles (corrosive sublimate). As a general rule, the octahedron and tetrahedron are isolated and detached, while the rest arrange themselves in groups, presenting the utmost variety. But even the detached octahedra are subject to modifications of position and imperfections of structure, which, without some explanation, might lead to difficulties in diagnosis. As the typical crystal of a most important poison (arsenious acid) these modifications and imperfections, with the exceptional forms to be found in almost every group of crystals, may be advantageously considered.

The regular octahedron is shown in outline in fig. 172; as it

Fig. 172.

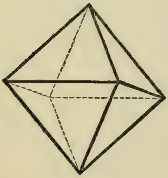


Fig. 173.

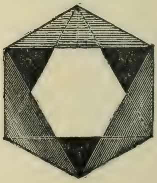
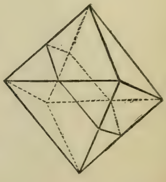


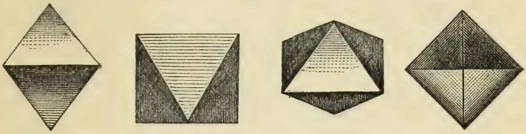
Fig. 174.



appears when a glass model of it is seen with a triangular facette in advance, in fig. 173; and as cleft by a plane parallel to two of its sides in fig. 174. It consists of eight equilateral triangles joined at their edges; and a section passing through four edges, so as to divide the crystal into two equal parts, shows a perfect square. The section shown in fig. 174 also divides the crystal into two equal parts, each of which has an equilateral triangle

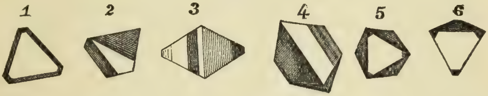
for one face and a hexagon for the other. The entire crystal presents itself under different aspects, according as it adheres by an angle, face, or edge, and the light traverses, or is reflected from it. In opaque models, or in groups of crystals seen by reflected light, two, three, or four sides only are displayed as in the annexed illustrations (fig. 175). But when the light is trans-

Fig. 175.



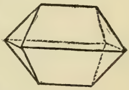
mitted through the crystals, these forms are modified and disguised by such shadows as those shown in fig. 176. It is not often

Fig. 176.



that the eight sides of the octahedron are visible, as in the fifth of the series, in which the three receding triangles and three dark triangular spots represent six sides, and the two parallel equilateral triangles, the seventh and eighth. Sometimes the octahedron, instead of being moulded on a square, is built on an oblong, assuming the form shown in fig. 177.

Fig. 177.



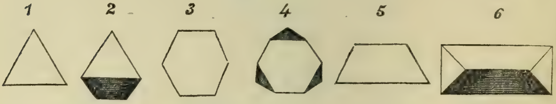
In most groups of crystals these forms will be recognised; but it should be understood that the octahedron is not always perfect. Its angles may be truncated, sometimes one, sometimes more than one, sometimes all. Its sides may also be indented and its angles rounded, so as to resemble a trefoil (fig. 178).

Fig. 178.

Again, the half crystal formed by the section indicated in fig. 174 like the entire crystal, may present itself in many different attitudes:—1, as a simple equilateral triangle; 2, as an equilateral triangle resting on half the adjoining triangle as a base; 3, as a simple hexagon; 4, as a hexagon with three small equilateral triangles in shadow; 5, as a truncated equilateral triangle; 6, as a figure having the appearance of a triangular prism (fig. 179).

These half crystals, by the juxtaposition of their corresponding

Fig. 179.



parts constitute twin crystals, or *macles*, as in figs. 180 and 181. Rectangular prisms, of which fig. 182, faithfully drawn from a photograph, contains two specimens, are of less frequent occurrence.

Fig. 182.

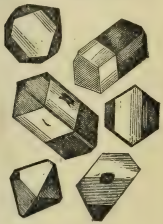
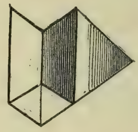


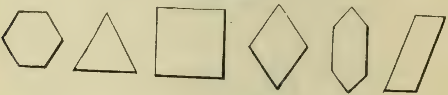
Fig. 180.

Fig. 181.



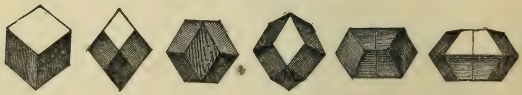
Plates various in form, size, and thickness, are also very common in some specimens (fig. 183).

Fig. 183.



The rhombic dodecahedron, in the various positions shown in the first four of the figures annexed (fig. 184), and the *macles*, or twin-crystals, depicted in the fifth and sixth, go far to complete the history of the crystals of arsenious acid taken as an example of a crystal of definite form, putting on appearances the most various through difference of position, imperfect development

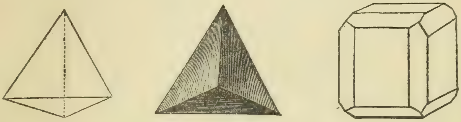
Fig. 184.



rotation of half crystals, and modifications of form in harmony with the cubical system to which it belongs.*

Fig. 185.

1. 2. 3.



Another crystal which has a certain medico-legal interest, from being present in some deposits from solutions of tartar emetic, is the tetrahedron, shown in outline in (1) fig. 185, together with the alternative form consisting of a cube with its edges removed, as at 3.

The tetrahedron consists of four equilateral triangles, joined at their edges, and presents itself very constantly in the manner shown in the shaded crystal (2, fig. 185).

The remaining crystals with which we have to deal in medico-legal inquiries are chiefly the prismatic forms and plates which

Fig. 186.

1. 2. 3.

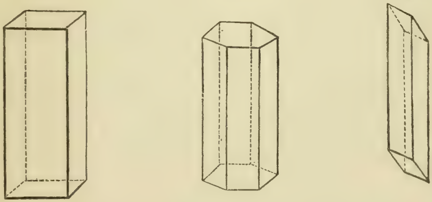
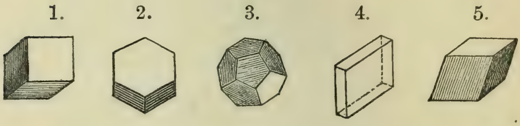


figure so largely among the sublimates and deposits from solutions of the alkaloids. Those most deserving of notice are: 1, the rectangular four-sided prism of strychnia; 2, the six-sided prism of morphia; 3, the right rectangular prism of oxalic acid and sulphate of zinc.

* Those who desire fully to understand, or clearly to explain, the crystals of arsenious acid, should study them on the large scale in octahedra of wood and glass, referring to the 'Mineralogy and Crystallography' of Tennant and Mitchell, and using the binocular microscope.

The cubic crystal of iodide of potassium and common salt (1, fig. 187), the deep six-sided plates of strychnia, as deposited from solutions in benzole (2), the pentagonal dodecahedron found in the same deposits (3), and the deep square plates of bichromate and ferrocyanate of potash (4), are also worthy of attention. The rhomb (5), is of less medico-legal interest.

Fig. 187.

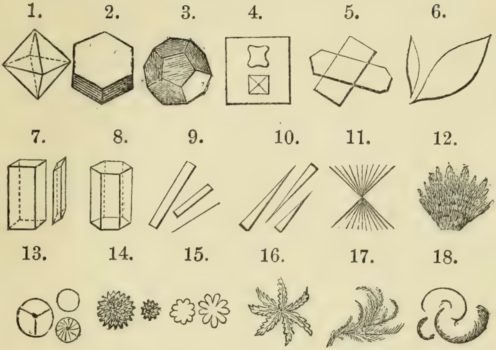


Crystals, then, whether obtained from inorganic or organic sources, by sublimation, or from solutions in various menstrua, are subject to great variation in form and grouping.

The chief causes which determine the forms of crystals are, temperature, quantity of material, and strength of solution. Of *temperature*, it will suffice to observe that, as in the case of sublimates of arsenious acid, it will determine whether a deposit shall be crystalline or amorphous, in others, as in solutions of common salt, whether the cyrstals shall be cubes or octahedra ; of *quantity*, that, as often happens with the sublimates of the alkaloids, the smaller the quantity the more defined the crystals ; of *strength of solution*, that this will sometimes determine the form of compound crystals, as in the case of bichromate of potash, which, in strong solution, yields deep plates and prisms, in weak solution, a delicate arborescence. (Figs. 85 and 86 and p. 509). Hence the strength of solutions to be tested, as well as that of reagents, should always be indicated. In the case of crystals forming under the microscope, the depth of the liquid is a notable cause of variation, for different forms of crystal will develop themselves in a deep undisturbed drop and in a thin layer, such as results from the use of a covering glass.

The crystals of the alkaloids, and of other organic poisons, whether obtained by sublimation, by liquid reactions on dry spots, or by reactions of liquid with liquid, are subject to even greater variety of form, position, and grouping, than those of the inorganic kingdom. But some of the difficulty hence arising is removed if we can succeed, by repeated experiment and microscopic examination, in discovering the elementary crystalline form, which, by its various groupings, occasions the varieties that perplex us. This I have been able to effect in a certain degree ; and to bring together in one table (fig. 188), the leading forms which I have encountered during a long series of experiments.

Fig. 188.



Forms 1, 2 and 3 have been already described (p. 562) as occurring in deposits from a solution of *strychnine* in benzole. The square plate (4), often modified by indentation and cross marking, as in the small enclosed figures, coincides with variously formed groups of plates and needles (9); and are quite characteristic of the *instantaneous* reaction of bichromate of potash and *strychnine*, and of the slower reaction of the alkaloid with bichloride of platinum. The long rectangular plates (9) variously crossed and grouped are equally characteristic of the *instantaneous* reaction of *strychnine* and the sulphocyanide of potassium; and also of morphine with tannic acid—the former in groups of rare length and beauty, the latter much smaller, and usually detached. The wide oblong plate variously truncated (5), and disposed in groups, belongs to the reactions of brucine with sulphocyanide of potassium, and with corrosive sublimate; while the leaf-like or winged form (6) blended with oblong plates (5), marks the quick reaction of *brucine* and ferricyanide of potassium, in which the iridescent colours of the thin curved plates projecting into the liquid at every angle, recall to the mind some of the most delicate and beautiful of insect forms The square prisms (7), and the hexagonal prism (8), belong to strychnine and morphine respectively; and the flattened prism (7) to oxalic acid. The pointed crystals (10) are seen in perfection in the reaction of strychnine and the spirituous solution of iodine with sulphuric acid. The double group of needles radiating from a point (11) occurring, as it does, with crystals of straight and curved outline (5 and 6) in the reaction of brucine with the red prussiate of potash, is eminently characteristic. Such forms radiating from a point are common in many marginal crystals—

e.g., *strychnine* with iodo-iodide of potassium, and *morphine* with hydrochloric acid. Tufts (12) are common in deep drops, when in shallower ones groups of needles or fine prisms abound. The disks faintly marked (13), thicker and coarser (14), and with curved edges (15), are blended with other crystalline forms; those of (15) being common in the reaction of strychnine with perchloride of iron. The star-fish crystal (16) is seen, large and perfect, in the reaction of *brucine* with nitroprusside of sodium. The dendritic or arborescent form (17) occurs in the reaction of *strychnine* with terchloride of gold, and in a marked manner with carbazotic acid, the elementary form which specially marks that reaction being the curved claw-like figure (18). Dendritic forms are also common in deposits from crystalline solutions. Several of these reactions were described in a former edition of this work for the first time; after repeated experiment and frequent comparison with other reactions.

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THE END.

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